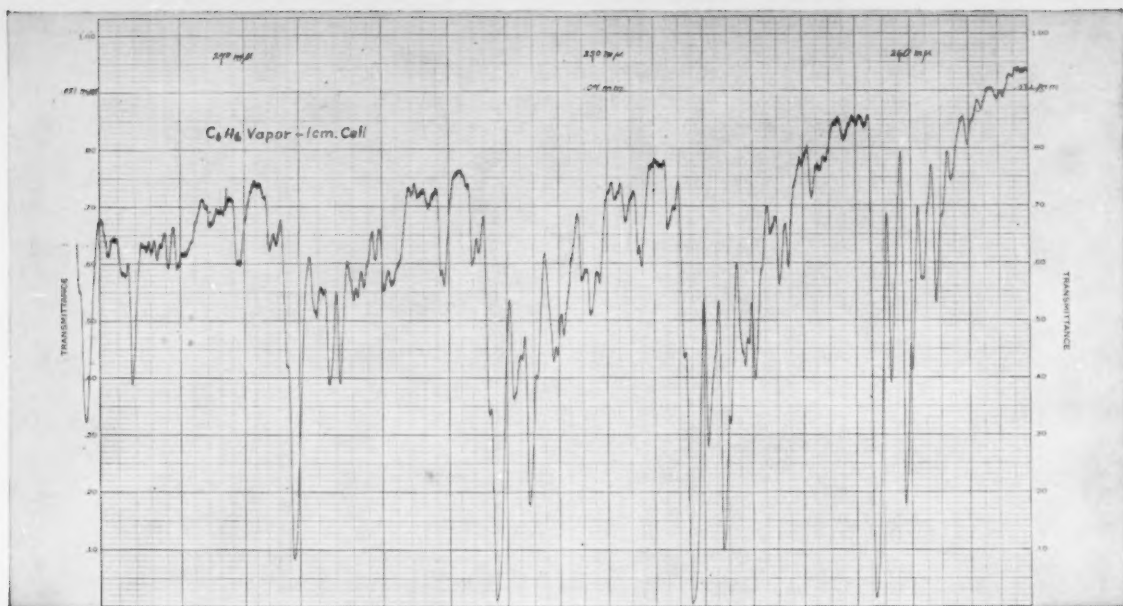


SCIENCE

3 February 1956

Volume 123, Number 3188

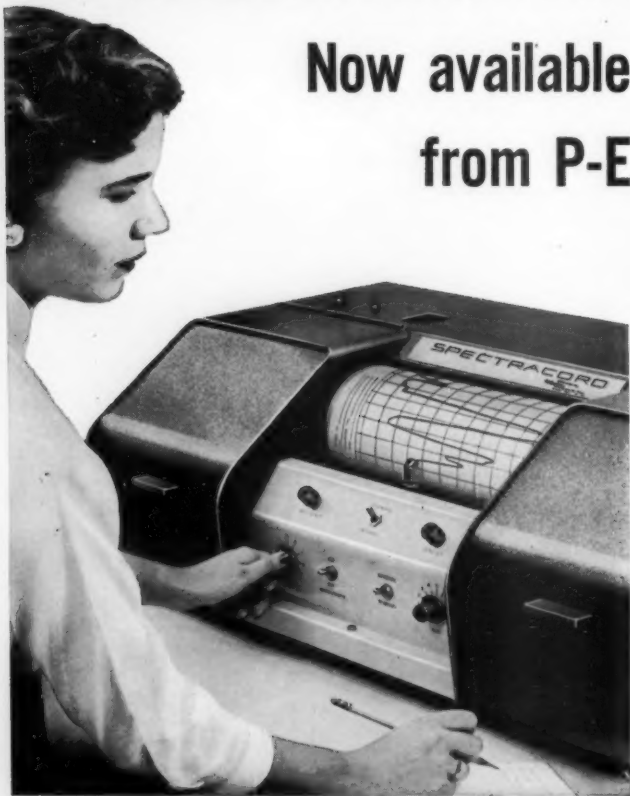
Editorial	The Spirit of Science	165
Articles	Wisconsin Climate and Life Zones in North America: <i>L. S. Dillon</i>	167
News of Science	NSF Institutes for Science and Mathematics Teachers; New AAAS Associate Society; Radioisotope Distribution; Salk Vaccine in Massachusetts; Grasshoppers on the Rangelands; News Briefs; Scientists in the News; Recent Deaths; Education; Grants, Fellowships, and Awards; In the Laboratories; Miscellaneous	177
Reports and Letters	Quantitative Underwater Study of Benthic Communities Inhabiting Kelp Beds off California: <i>A. A. Aleem</i>	183
	Metabolite of Phenobarbital in Human Urine: <i>E. J. Algeri and A. J. McBay</i>	183
	Body Composition and Energetics in Obesity Induced in Mice by Adrenotropic Tumors: <i>J. Mayer, C. Zomzely, J. Furth</i>	184
	Summer Jobs for High-School Students: <i>J. G. Busse</i>	185
	Magnetic Techniques for <i>in vitro</i> Isolation of Leucocytes: <i>S. Levine</i>	185
Book Reviews	<i>Quantum Mechanics; Cardiovascular Renal Problems; Principles of Meteorological Analysis; Solar Energy Research; Determination of Organic Structures by Physical Methods; Magnetic Materials in the Electrical Industry; Books Reviewed in The Scientific Monthly, February; New Books</i>	187
Scientific Meetings	Low-Temperature Physics; Meeting Notes; Forthcoming Events	190
	Equipment News	195



The Warren Spectracord* Unit

with a New DOUBLE Monochromator

Now available
from P-E



The Warren Spectracord—well known as a versatile and reliable recording unit for ultra-violet monochromators—has joined the Perkin-Elmer family of products. In addition, a new *double* monochromator, expressly designed for use with the Spectracord is also available from P-E.

A Spectracord equipped with the new double monochromator permits greatly improved performance over the earlier single monochromator combination at a nearly comparable price. Stray radiation is reduced to the vanishing point. Resolution is increased throughout the range. Operation at considerably higher absorbancy levels is thus possible.

The Spectracord is still available as an attachment to existing single monochromators. As a Perkin-Elmer product it is now backed by P-E's extensive service and application engineering facilities.

If you are considering expanding your UV facilities, either through additional equipment or by modernizing your present monochromator, why not consider the Spectracord? We will be glad to supply complete information.

*T.M. Warren Electronics, Inc.

Perkin-Elmer

CORPORATION
Norwalk, Connecticut

Saunders announces **The Handbook of Toxicology**

A 5-volume work sponsored by the National Research Council
—the most comprehensive collection of data ever compiled on
the toxic qualities and dosages of all substances which have
known adverse effects on living organisms.

Volume 1 - Just Ready

Acute Toxicities of Solids, Liquids and Gases to Laboratory Animals

In easy-to-read tabular form

NEW!

Edited by WILLIAM S. SPECTOR. Prepared under the Direction of the Committee on the Handbook of Biological Data. Division of Biology and Agriculture, National Academy of Sciences—The National Research Council. Principal Contributor—WOLFGANG F. VON OETTINGEN, M.D., Ph.D., Chief Toxicologist, The National Institutes of Health, Bethesda, Maryland. Volume I, 408 pages, 8½" x 11". \$7.00.

New—Just Ready!

This new book lists 2363 chemical compounds and indicates lethal dosages of each in various laboratory organisms.

From the data given the toxicologist can determine for himself what represents a toxic fatal dose in human beings. The introductory material explains how data provided in tables for rats may be applied with broad limits to humans. This book in easy to read tabular form will helpfully serve as a ready reference.

Watch for these forthcoming volumes

VOLUME II —Anti-infectives—Chemical Carcinogens—Metabolites of Toxic Compounds.

VOLUME III—Pesticides.

VOLUME IV—Poisons and Poisoning.

VOLUME V —Pollutants—Chronic Toxicities—Industrial and Radiation Toxicity.

W. B. Saunders Company

West Washington Square

Philadelphia 5

*It's FAST...
it's ACCURATE...
and it's
LOW IN COST*



CENCO Triple Beam Balance

Here's an ideal balance for the classroom. It combines versatility, sturdiness and low cost with accuracy and dependability. It is made with three separate graduated beams which permit readings from 0.01 gram to 111 grams without the use of loose weights. Sensitiveness is 10 mg. Important features include agate bearings, hardened steel knife edges, beam release mechanism and support for specific gravity specimens. The overall size is about 13½ x 12 x 4 inches.

Order today for immediate delivery.

No. 2640 Cenco Triple Beam Balance.....\$30⁰⁰

(No. 2648 extra weight for weighings up to 201 grams....\$2²⁵



Central Scientific Company

1718-M IRVING PARK ROAD, CHICAGO 13, ILLINOIS

BRANCHES AND OFFICES—CHICAGO • NEWARK • BOSTON • WASHINGTON • DETROIT • SAN FRANCISCO •
SANTA CLARA • LOS ANGELES • REFINERY SUPPLY COMPANY—TULSA • HOUSTON
CENTRAL SCIENTIFIC CO. OF CANADA, LTD.—TORONTO • MONTREAL • VANCOUVER • OTTAWA

AMERICAN ASSOCIATION
FOR THE
ADVANCEMENT OF SCIENCE

Board of Directors

PAUL B. SEARS, *President*
LAURENCE H. SNYDER, *President Elect*
GEORGE W. BEADLE, *Retiring President*
WALLACE R. BRODE
PAUL M. GROSS
GEORGE R. HARRISON
MARK H. INGRAHAM
PAUL E. KLOPFER
CHAUNCEY D. LEAKE
MARGARET MEAD
THOMAS PARK
PAUL A. SCHERER, *Treasurer*
DAEL WOLFE, *Executive Officer*

DAEL WOLFE, *Executive Officer*

GRAHAM DUSHANE, *Editor*

CHARLOTTE V. MEETING, *Assistant Editor*

Editorial Board

MARK H. ADAMS	KARL LARK-HOROVITZ
WALLACE R. BRODE	EDWIN M. LERNER
BENTLEY GLASS	WILLIAM L. STRAUS, JR.

Editorial Staff

PEARL BOBBER, SARAH S. DEES, JOAN DELL, JUNE M. FORBES, OLIVER W. HEATWOLE, M. DALE HOOPER, YUKIE KOZAI, ELLEN E. MURPHY, ROBERT V. ORMER, BETHSABE PEDERSEN, JOSEPH TURNER, JACQUELYN VOLLMER

EARL J. SCHERAGO, *Advertising Representative*

SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of 3 March 1879.

SCIENCE is indexed in the *Reader's Guide to Periodical Literature* and in the *Industrial Arts Index*.

Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors.

Display-advertising correspondence should be addressed to SCIENCE, Room 604, 11 West 42 St., New York 36, N.Y.

Change of address: The notification should reach us 4 weeks in advance. If possible, please furnish an address stencil label from a recent issue. Be sure to give both old and new addresses, including zone numbers, if any.

Annual subscriptions: \$7.50; foreign postage, \$1; Canadian postage, 50¢. Single copies, 25¢. Special rates to members of the AAAS. Cable address: Advancesci, Washington.

The AAAS also publishes THE SCIENTIFIC MONTHLY.



The Spirit of Science

Most scientists would probably agree that the popular concept of the methods and aims of science is wide of the mark. Science fiction, the movies and television, and even some works of literature often present a view of science that the scientist finds too absurd to consider seriously, much less rebut. Some extremists among the humanists seem to fear that scientific analysis has driven beauty from the world and, by picturing man as a machine, has destroyed any possibility of human dignity and self-respect. Science, if properly understood, is no enemy of the highest aspirations of man and has no inherent incompatibility with the arts.

It is unfortunate that the audience that would profit most in understanding is not likely to read Warren Weaver's presidential address to the AAAS at Atlanta [*Science* 122, 1255 (1955)], for his discussion would go far toward dispelling these misconceptions. Weaver considered science broadly and concluded that his "comments do not support the concept of science as some kind of super creed, magical and mysterious as it is all-powerful, arrogant from its successes, and avid to invade and conquer, one after another, all the fields of human activity and thought. This viewpoint does not justify the notion that science is so special as to be unique, as well as so curious as to be incomprehensible. . . . On the contrary, these descriptive comments picture science as the servant of man, not his master; and as a friendly companion of art and moral philosophy. . . . It is a natural expression of both his curiosity and his faith."

Surely few scientists would disagree. It is clear that Weaver does not expect science to answer ultimate questions or, in Aldous Huxley's phrase, to put "salt on the tail of the Absolute." The modern attitudes of science are in the tradition of the Greek philosophers; Plato would doubtless have felt at home with our approach to the modern picture of the material world: science deals with appearances, with events. The events are linked to one another by a series of concepts, and these in turn furnish a base for further inferences, which may or may not be supported by the observed relationships between the events that they predict. The structure of scientific knowledge is a mental structure—a conceptual tapestry woven from the gossamer threads of thought. Who is bold enough to say what relationship the tapestry has to the reality behind it? That there is some regular relationship may be inferred from the success of prediction: the most highly developed branches of science can predict what images will appear in the unfinished parts of the tapestry; here and there new threads are added, and order and beauty emerge when apparently unrelated fragments unite to a harmonious whole.

But this is only a metaphor and one that each scientist would prefer to formulate for himself. To return to a safer position and one less likely to arouse philosophic argument, it seems both regrettable and indefensible to think of science as dull fact-grubbing, and the arts alone as creative, for the conceptual universe depicted by science is a product of the creative imagination. Science and the arts in different ways pursue a common end; they are expressions of man's effort to bring order and beauty and understanding into his life.—G. DuS.

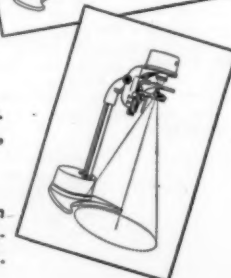
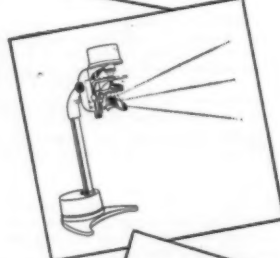
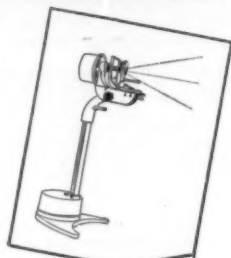
NEW!



\$150.00

BAUSCH & LOMB *tri-simplex* MICRO-PROJECTOR

- Brighter, clearer images, on screen or tracing pad ...
 - Faster, easier operation ...
- ... than any other micro-projector in the school-budget range!



BAUSCH & LOMB

SINCE  1853

America's only complete optical source... from glass to finished product.

WRITE TODAY FOR
CLASSROOM DEMONSTRATION
and informative Catalog E-248.
Bausch & Lomb Optical Co.,
64202 St. Paul Street,
Rochester 2, New York.

See it at the American Association
of School Administrators Conven-
tion, Atlantic City, February 18-23.
B&L Booths J-20, J-21.

Wisconsin Climate and Life Zones in North America

Lawrence S. Dillon

In attempting to understand some speciation problems revolving around certain North American beetles, I discovered a need for more detailed information concerning the climatic and biogeographic conditions that prevailed at the maximum of the last glacial period. Although many recent studies of isolated localities—especially in the form of pollen analyses of peat bogs—were found, there appeared to be no broader study available that presents the over-all picture. The present paper (1) is an attempt to reconstruct more concretely the conditions indicated from the admittedly rather scanty data at hand.

Climate of Ice Sheets

Since it is natural to think of ice sheets as occurring in regions of the most intensive winter cold, it is somewhat of a surprise to discover that lower cold-month mean temperatures exist in areas that have no permanent ice cover than in those that have. In central Asia, for example, there is an extensive area that has a January mean of -50°F , according to Haurwitz and Austin (2); surrounded by an equally extensive belt with a corresponding mean of -40°F ; nevertheless, the entire region, except in the high mountains, is unglaciated. In contrast, on the Greenland icecap and on Antarctica, which is nearly entirely glaciated, we find cold-month means that are considerably milder, between -20°F and -30°F .

Since extremely cold winters alone, then, do not satisfactorily explain the presence or absence of ice cover, we turn

next to annual precipitation as an index to ice formation, for perhaps the steppes of Siberia and Inner Mongolia are too dry to permit formation of an icecap. But this too fails to appear as the limiting factor, for, while Greenland and Antarctica have less than 10 inches of precipitation annually, much of central Asia has well over that figure—in fact, up to 20 inches in a broad part of the region. Nevertheless, a study of the rather scanty climatic data that are presently available reveals that the annual precipitation, understandably enough, is of great importance. In Antarctica, where the annual mean is $7\frac{1}{2}$ inches (at Little America), the ice sheet is diminishing rather rapidly, while in Greenland, where the mean is closer to 9 inches, the diminution is somewhat slower. Hence, it might be postulated that a minimum annual mean of 12 inches is essential for the maintenance of an ice sheet and that more than this is essential for the formation and growth of an ice sheet on a continental basis.

However important annual precipitation may be as a contributing factor for glaciation, the delimiting factor must be sought elsewhere, perhaps in the melting that is possible during the warm season. Examination of warm-month means seems to point quite obviously to a maximum mean of 45°F as the factor that restricts ice sheet formation, for no present continental glaciation occurs anywhere in the world where the warm-month mean exceeds this; nor, as far as figures are available, do the snow lines of mountains extend into regions with higher temperatures. For example, all except one major glacier of eastern Canada and the whole of the icecap of Greenland lie north of the July mean of 40°F , and this sole exception lies far north of the correspond-

ing mean of 45°F . Antarctica lies far south, similarly, of the January mean of 40°F , and, in fact, mean daily temperatures rarely go above freezing anywhere on that continent. On the other hand, the great plateaus of central Asia, with their very low winter temperatures and fairly abundant rainfall, have July means of 50°F or more, and hence appear to be unable to maintain extensive, permanent glaciation.

From Fig. 1, it may readily be observed that the farthest advance of the Wisconsin ice sheet (3) extended, except in the central plains and Pacific Coast regions, not greatly beyond the present isotherms of mean July of 70°F and mean January of 20°F , a range of 50° . Assuming a similar range for the latitude during the last ice age and accepting the foregoing discussion as essentially correct, it is possible to postulate that these isotherms could have had values of 45°F and -5°F , respectively—a total decrease for the upper latitudes of 25°F . Furthermore, until the time when continental glaciation had progressed in North America as far south as the present belt of 15 or more inches of rainfall, we must also postulate some increase in annual precipitation. Once that point had been reached, the conditions prevailing at the present time would be ample for continued growth insofar as moisture is concerned.

Climate of Unglaciated Regions

If, then, the temperatures of the polar climates decreased, as it would appear, a total of 25°F , does it follow that those of the remainder of the continent diminished to the same extent at the maximum period? The evidence, scanty as it is, seems to indicate otherwise.

In the eastern part of the continent, most of the evidence, based as it is largely on palynological studies of peat deposits, is biogeographic in nature and hence indirect. In the western portion, however, the presence of ancient snow lines and glacial moraines on the mountain peaks provides much more direct information on the depression of temperature that occurred during the Wisconsin period. Ernst Antevs (4), in a recent study of a north-south series of peaks along the 105th meridian in the southern half of Colorado and in northern New Mexico, deduces a general depression of tempera-

The author is associate professor of biology at the Agricultural and Mechanical College of Texas, College Station.

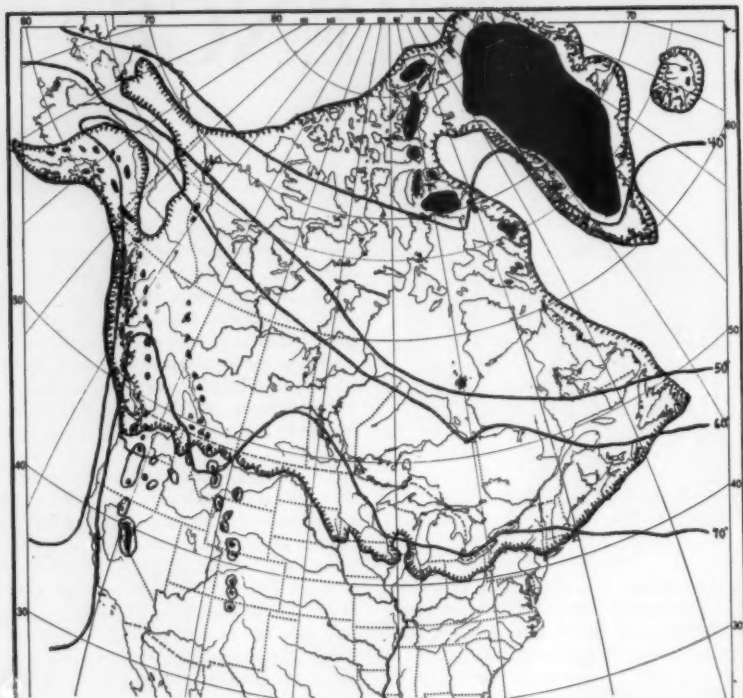


Fig. 1. Glaciation of the Wisconsin ice age compared with that of the present. Black areas, existing glaciation; hachured outline, Wisconsin glaciation. Isotherms are July means in degrees Fahrenheit.

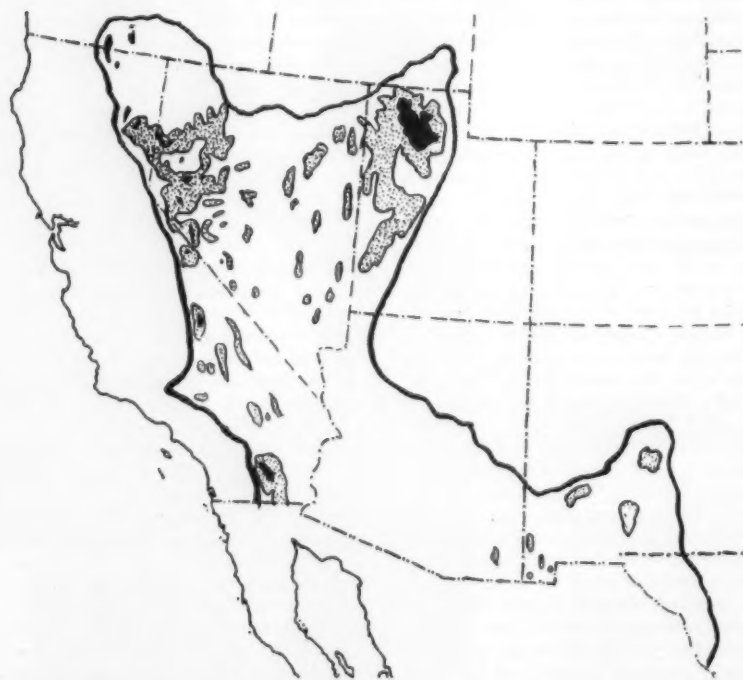


Fig. 2. Basin and Range region. Present pluvial lakes are shown in solid black; extinct pluvial lakes are indicated by stippling.

ture for the area of only 10°F . In this same paper, as well as in a similar study that was published earlier (5), he finds that the maximum of former very extensive lakes of the Basin and Range region (see Fig. 2) was reached simultaneously with that of the Cary substage; and he concludes that there was an increase in rainfall of 9 inches per year for the area. However, his conclusions are based on the assumption that no increase in rainfall occurred in the Pikes Peak area and may be in error to some extent. Nevertheless, his estimate of the temperature drop is in close accord with that of other workers (6) for regions of comparable present-day climates, such as southern Europe and Japan.

For latitudes farther north or south, there are no available data of this sort for North American localities. However, Meyer (7) found a depression of about 5° to 6°F for the equatorial Andes at the Wisconsin maximum.

In summary then, there appears to have occurred at the period of maximum glaciation a clinal depression of mean temperatures that amounted to 5°F at the equator, to 10°F at latitudes 35° to 40°N , and to 25° at the edge of the ice sheet. If one keeps in mind the curvature of the earth's surface in relation to the angle of the solar rays, such a cline does not seem illogical. On the other hand, the only apparent alternate hypothesis—that of a uniform depression of the mean temperature of, say 10°F —would suggest a July mean of 60°F for the ice sheet's lower boundary, which is similar to that of present-day England or northern Germany, or of the state of Maine, but with somewhat colder winters. Since no glaciers or permanent snow fields are known to exist today under such relatively mild climates, it seems scarcely likely that they could have done so in former times.

With the advent of the huge stretch of ice covering the upper half of the continent, it appears probable that a mean annual low-pressure system would have developed over the glaciated region. As a result, the mean annual cyclonic path, which at present enters the continent at about the latitude of Oregon, would have been displaced to the south so as to strike just above the middle California coast. From there it would have continued across the southern Rocky Mountains, leaving the east coast perhaps in the vicinity of South Carolina. Despite a slight decrease of evaporation in the equatorial regions owing to the temperature drop, the net effect of these changes would have been an increase in precipitation—as the result of increase in violence of the interactions of cold and warm air masses—in much of a southern belt across the nation. Therefore, we

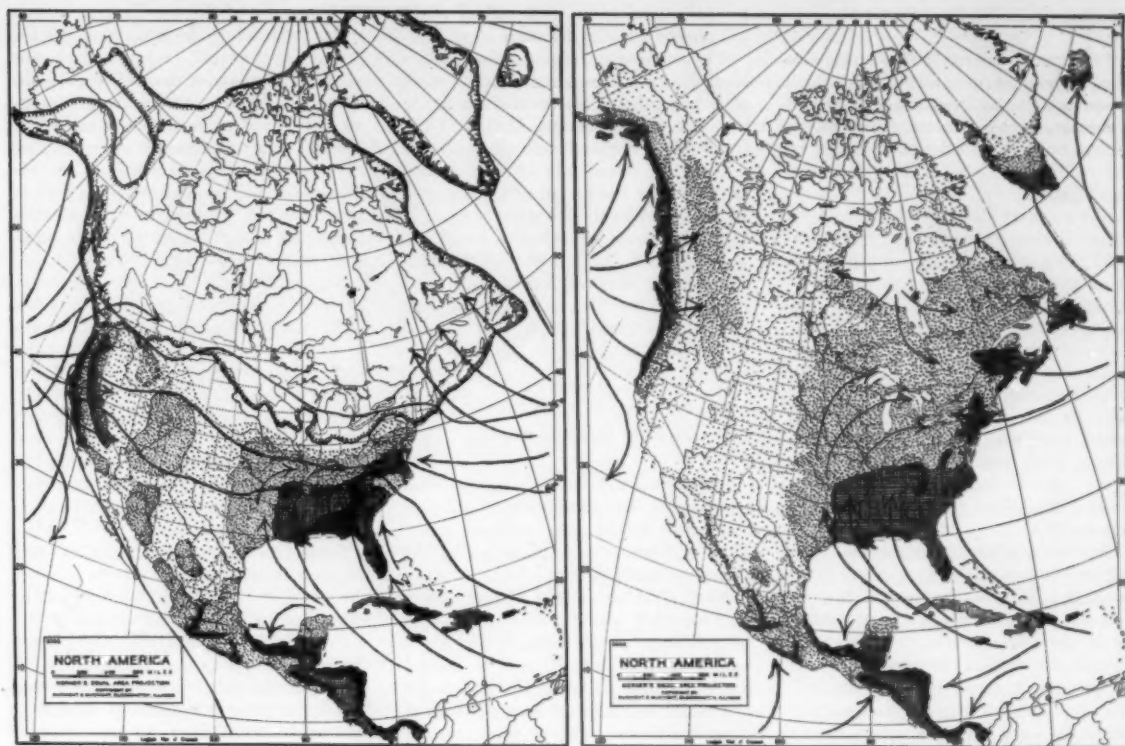


Fig. 3 (left). Hypothetical mean annual rainfall at the maximum of the Wisconsin glaciation. White areas, regions with less than 10 inches; lightly stippled areas, regions with 10 to 20 inches; heavily stippled areas, regions with 20 to 40 inches; crosshatched areas, regions with 40 to 60 inches; black areas, regions with more than 60 inches. Isotherms are July means in degrees Fahrenheit. Fig. 4 (right). Present mean annual rainfall. Legend same as that for Fig. 3. The arrows indicate the sources of atmospheric moisture.

might postulate a much more moist climate for the southwestern portion of the present United States as well as for the southeastern part, perhaps not too unlike the rainfall zonation suggested in Fig. 3 (compare Fig. 4). The diminished mean precipitation proposed for the belt across the northern tier of states would result from the dry, cold, expanding air masses descending off the icecap as a result of the anticyclonic circulation.

This postulated cline of precipitation, declining from south to north—at least for the western states—might be substantiated from the ancient snow lines of some of the mountain peaks, if Antev's figures are accepted. In the studies previously mentioned, he suggests a displacement of 3000 feet downward for each decrease in mean temperature of 10°F . At Mount Rainier, Washington, where the mean temperature possibly decreased twice this amount, we would expect to find a lowering of the snow line of 6000 feet, 5500 feet being actual according to Flint (8). Hence, because of the proximity of this mountain to the coast, only a slight discrepancy is noted, and we might suggest only a small drop in mean annual

rainfall, say from the present 100 inches to perhaps 80 or 90 inches. However, at Glacier National Park in Montana, the lowering of the snow line amounts to only 4500 feet despite the fact that the area must have suffered a temperature drop of close to 25°F at maximum glaciation. Here the discrepancy from the predicted amount is about 3000 feet, which might be explained by a decrease in annual precipitation to about one-half of its present 30-inch mean.

Development of the Ice Sheet and the Effect on the Biota

In order to describe the development of the continental ice sheet, we must first postulate an increase in precipitation, not over the whole of the earth, but at least in the region of Greenland and north-eastern Canada to begin with. Because there is an abundant source of atmospheric moisture from the prevailing Iceland low pressure area, as well as from Hudson Bay during the warm months, it would not require too radical a meteorological change to increase the present

mean annual rate (about 9 inches) to the minimum requirement of about 15 inches per year. Following this increase, in the second place, a gradually diminishing mean temperature in the more polar latitudes must be postulated. As the temperature fell and the glaciation increased in extent, the mean path of cyclones likewise was gradually moved southward, as was also the position of the Iceland low. Hence the greatest thickness of the glaciation would always be nearest the sources of moisture, with an attenuation in depth away from these areas. With these considerations in mind, it becomes possible to draw a series of maps, such as those in Figs. 5 to 9, to indicate the stages in the gradual development of the ice sheet.

As the glaciation increased in extent, the biota of the continent, naturally enough, was greatly influenced by the resulting changes. To understand better some of the details of these effects, as well as those of the glaciation and climatic changes that are not apparent from other sources, it may be well to examine some data from palynological and biogeographic sources.

Evidence from Northern States

Potter (9) analyzed the pollen content of 15 bogs in northern Ohio, all of which are postglacial, and found a sequence of dominant tree genera, from then to the present time, as follows: *Picea*, *Abies* and *Pinus*, *Betula*, *Quercus*, *Tsuga*, *Carya*, and *Fagus*.

At Cranberry Glades, W. Va., with an elevation close to 3400 feet, Darlington (10) made a study of the bog deposits. Since geologic evidence points to the formation of these bogs by the flooding caused by melting of the glacier, the lowest depths are actually slightly postmaximum. Nevertheless, pollen analysis of the lowermost levels (13 feet 6 inches) indicates more than 70 percent fir and spruce, more than 20 percent other cold-climate trees, and about 5 percent oak. Above the 11-foot depth, the profile shows a flora quite similar to that of the present time.

Decvey's studies in Connecticut (11) and in other localities in southern New England (12) show a parallel history, with spruce and fir strongly predominating at the lowest levels, followed by a gradual resumption of modern floral components. As would be expected, Fuller's (13) account of postglacial vegetation of the Lake Michigan region, Lane's (14) work on peats of Iowa, McCullough's (15) study of a locality in central New York, and Rosendahl's (16) description of the Pleistocene flora of Minnesota show a similar history for each region concerned. Numerous other stud-

ies (17) have been made, all of which tell almost exactly the same story.

The net result of the afore-mentioned studies is the confirmation of the presence of a belt of fir and spruce across the northern section of the United States from New England into the Central States area, which followed the retreat of the glacier northward and was gradually replaced by more southerly types of vegetation until present-day conditions were attained. Furthermore, all the studies indicate that fir and spruce were strongly predominant at the time of their maxima—in combination, they formed 70 percent or more of the total tree pollen.

Evidence from Southern States

Pollen studies in southern localities reveal profiles that are somewhat different from those in the more northern states. These differences may be shown by the following citations.

North Carolina. Frey (18) presents a very detailed analysis of pollen taken from borings in the floor of Singletary Lake, which is located on the coastal plain of North Carolina. *Picea* appears at a depth of about 12 feet at most of his stations and is present from there to the final depth of 21 feet 7 inches, but in small quantities ranging from a fraction to 7.3 percent of the total tree pollens. *Pinus* and *Quercus* are present in abundance throughout all the borings, the former composing anywhere from 13.4 to

91.6 percent of the tree pollens at any given level, while the latter ranges from 1.7 to 63.5 percent. *Taxodium* is present in small amounts, with only minor gaps, down to a depth of 20 feet. At the uppermost and again at the lowermost deposits, *Tsuga* occurs in amounts not exceeding 2 percent. Hardwoods make up the remainder of the tree species. Grass pollens never exceed 20 percent and usually range less than 10 percent of the total tree pollens. No palm, mangrove, or other tropical pollen is reported. Maxima are poorly indicated, but there appears to be some correlation between upsurges in the amounts of *Picea* pollen and the *Sphagnum* present. A fairly marked one occurs at about 12½ feet and is probably Mankato, according to radiocarbon dating. Between 14 and 14½ feet is a very strong upsurge, possibly Cary; around 17 feet is a lesser one, possibly Tazewell, and, finally, between 18½ and 20 feet is another, possibly Iowan.

Since *Quercus*, an austral genus, and *Picea*, a boreal one, are present at even the coldest period in approximately equal numbers, we could assume a climate for this comparatively brief period that was similar to that of New York if it were not for the presence of *Taxodium*. The latter genus is apparently restricted, first by poor drainage and second by a January mean temperature of 35°F. Since this is the present-day January mean of the southern Appalachians, it seems not unlikely that the climate at its severest was similar to this but moister, which permitted *Picea* to survive. This

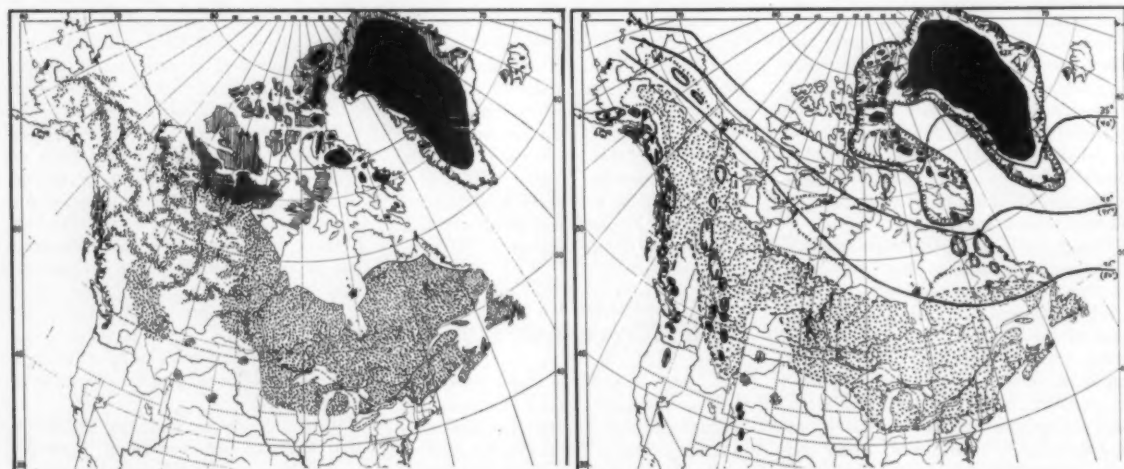


Fig. 5 (left). Present distribution of *Picea glauca* and musk ox in relation to extant arctic glaciation. Stippled area, range of *P. glauca*; crosshatching, range of *Ovibos moschatus moschatus*; horizontal lines, range of *O. m. niphoeus*; vertical lines, range of *O. m. wardi*; Black area, present arctic glaciation. Fig. 6 (right). Stage I in the development of the ice sheet, with a polar decrease in temperature of 5°F. Black areas, present glaciation; hachured lines, new limits of glaciation resulting from lowered temperature and increased precipitation in the region; stippled area, resulting new distribution of *Picea glauca*, the dotted line indicating its present actual limits. Isotherms are July means in degrees Fahrenheit; the new suggested values are above the isotherms, and the present actual values are in parentheses below the isotherms.

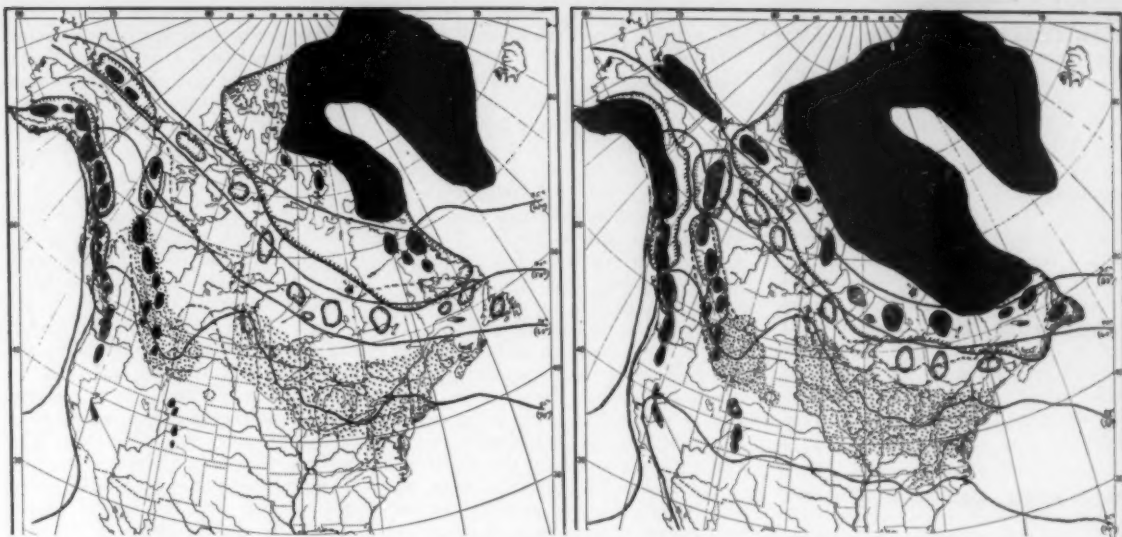


Fig. 7 (left). Stage II in the development of the ice sheet (total decrease in polar temperature 10°F). Black area, stage I glaciation; hachured lines, new limits of glaciation; stippled area, new distribution of *P. glauca*; dashed lines, limits of *P. glauca* in stage I. Isothermal legend same as that in Fig. 6. Fig. 8 (right). Stage III in the development of the ice sheet (total decrease in polar temperature 20°F). Legend same as that in Fig. 7.

maximum cold, which is equivalent to a decrease in winter temperature of 10°F and in the July mean of 5°F is indicated by the marked decrease in *Quercus* at the 13½- and 15½-ft levels. Perhaps, too, it would appear that the oak minimum marks the Mankato maximum more truly than do the spruce upsurges, for it is the only really sharply defined zone and includes at the same time maxima both for *Picea* and *Sphagnum*. The lowest depths would indicate a post-Cary origin of the lake and a continuing mild, moist climate during the interval.

Buell's (19) study of a North Carolina peat deposit, which is not so deep and appears to be more definitely placeable as Wisconsin in origin, is similar in detail. At the greatest depths, *Abies* pollen was found in amounts of 12 percent, along with *Pinus* and *Quercus* (38 percent each); *Carya*, *Betula*, and *Acer* make up the remainder.

Southern New Jersey. Potzger's (20) study of pollen spectra from bogs of the pine barrens of New Jersey reveals a profile not unlike that of Buell's study. The forests there during the Wisconsin glaciation contained northern elements but in rather limited percentages.

Florida peat-bogs. Unfortunately, Davis (21) in his excellent account of the peat bogs of Florida, fails to give a detailed, level by level analysis of the pollen that occurred in any peat deposit. Nevertheless, what records he does provide are of considerable interest. Near Tallahassee, at a depth of 90 to 96 feet (between 50 and 60 feet below present sea level) a

peat deposit that contains spruce pollen has been found; this peat rests on upper Oligocene deposits and is covered by shale, clay, and sandstone with limestone streaks considered by Davis to be Pleistocene or postglacial. On the neck of the peninsula in core holes, peat deposits containing pollen of spruce and fir have also been found. One of these, containing only the spruce pollen, is at a depth 50 to 54 feet (27 to 31 feet below present sea level), while another, containing pollen of both species, is 19.5 to 22 feet below the surface (corresponding to a distance of 0.3 foot above to 2.2 feet below present sea level). Above both these deposits are marine deposits, and over these in turn are two further peat deposits that are of fresh-water origin. No cold-climate pollens have been encountered south of this region; all the peats of the southern half of Florida contain pollens of present-day flora only.

Louisiana. The fossil woods listed by Brown (22) indicate a similar mixed forestation for Louisiana. The deposits he studied, in the eastern part of the state, are covered by some 10 to 20 feet of loesslike soil and are assigned to the "Peorian" (Two Creeks?) interglacial period. Along with the boreal white spruce trunks and cones are found preserved woods of transitional species such as American elm as well as fossils of the oaks, magnolias, swamp tupelo, and cypress that are characteristic of the region today.

Eastern Texas. In recent years, pollen studies of three Texas bogs have been

made by Potzger and Tharp (23). All three of these bogs show the presence of *Picea glauca*, *P. mariana*, and *Abies* at the lowest depths; the totals are 10 percent at the Gause bog in Milam County, 5 percent at the Paschke bog in Lee County, and about 1 percent at the Franklin bog in Robertson County. At these greatest depths, except at Paschke, where pines were dominant, grasses were present extensively and, in fact, made up close to 50 percent of the volume; they continue to dominate throughout most of the levels. *Quercus*, chestnut, alder, and pines are present, too, in small but significant volumes. At both the Paschke and the Franklin bogs, there is a scant reoccurrence of *Picea* at rather shallow levels—7 feet in the former, 5 feet in the latter. In no instance is there a report of the occurrence of tropical or semi-tropical pollens. The presence of only one other tree genus of possible importance—*Castanea*—is indicated; it is abundant at all three localities at levels corresponding to the reappearance of *Picea* and in those levels that are 1 and 2 feet above and below.

It is clear from these data that, throughout the southeastern United States, boreal tree species such as *Picea glauca*, *P. mariana*, and *Abies* sp. were at one time present, presumably at the time of the maximum of the last glacial epoch. However, it is likewise clear that, while these northern elements were present as far south as upper peninsular Florida, they never occurred in the belt from North Carolina (or even southern

New Jersey) to central Texas in amounts of more than 10 percent of the total tree population. Along with them persisted the tree species that are characteristic of the area today. While no studies are presently available for localities in the belt from Virginia to Kansas and Oklahoma we may presume that these areas were intermediate in climate and biotic types.

Before turning from palynological and fossil evidence to examine biogeographic data, I must point out one outstanding feature of the Texas bogs—the presence of an abundance of grass. Since eastern points lack this characteristic, it seems certain that this fact can have only one significance—that is, it indicates that the mean annual precipitation for the region was not greatly different from that of today.

Chiefly Biogeographic Evidence

Boreal forms. Today the musk ox, *Ovibos moschatus*, occurs, according to J. A. Allen (24), only in the tundra regions of the Arctic Archipelago and of the mainland west of the Hudson Bay, as is shown in Fig. 5. Three subspecies occur, *O. m. moschatus* on the mainland to the west, *O. m. niphocetus* along a small area of the Hudson Bay shore, and *O. m. wardi* throughout the Arctic Archipelago and along the coast of Greenland. According to G. M. Allen's account (25), these animals only rarely penetrate the low spruce forest that borders the tundra area. Hence, the musk ox is a fairly reliable indicator of tundra conditions. That such conditions prevailed just below the ice sheet is indicated by the finds of skulls of musk ox; Hay reports (26), however, only a very few specimens that are accurately assignable to the present species, as follows: (i) one specimen

from Fayette County, Iowa, is dated as Kansan; (ii) a good hind part of a skull was found at a depth of 8 feet in Sioux County, Nebraska, and could be Wisconsin; (iii) the third and last well-preserved find is a small skull from Wabash County, Minnesota, which is dated as late Wisconsin. Although numerous other finds of fossil "musk ox" skulls have been made, all of these have been assigned to other genera such as *Symbos*, *Boötherium*, and *Gidleya*. Since these genera are entirely extinct, their habitat requirements are unknown, but because of their abundance throughout the grass belt of middle North America as far south as Texas, it seems that they were prairie, not tundra, animals. Hence, there is no good evidence that severe polar conditions existed within the United States except in close proximity to the glaciation.

The modern distribution of musk ox can indicate one other point of possible interest, but, in this case, it concerns the melting of the icecap. Since no ecological factor is known that would explain the absence of these creatures from the east side of Hudson Bay, it might be suggested that the central portion of the glaciation disappeared first, while much of the region to the south and east of the bay was still covered by ice. This would be quite in accord with the precipitation distribution postulated here, which would suggest that the area just east of the Rocky Mountains received rather scanty precipitation and a resulting thin ice covering, while the opposite conditions prevailed in the extreme west and east.

Another boreal form, of even more importance, possibly, than the musk ox, is the white spruce, *Picea glauca*. This species, the black spruce (*P. mariana*), the tamarack (*Larix laricina*), and balsam fir (*Abies balsamea*) are the characteristic trees, according to Harlow and

Harrar (27), of the great belt of northern evergreen forest that stretches across the continent from Labrador to Alaska. Since these four have essentially the same ecological requirements, as is indicated by their constant close association, it will suffice to discuss only one of them, the white spruce, in detail.

The belt of white spruce is limited on its southern edge, in the region of 20 or more inches of annual rainfall, by the July isotherm of 70°F. Farther west, where the rainfall is scantier, its lower border is withdrawn to the north. In the western portion of its range into Alaska, the tree is found primarily along the banks of lakes, streams, and bogs. In Alaska, it is confined to the interior, never ascending the coastal mountains to heights of more than 2500 feet. The northern edge of its range is defined by the limit of the area of perpetually frozen soil. Grading into the species proper toward the north, there is found—throughout the Canadian Rocky Mountains, in isolated patches in Montana and Saskatchewan, and in the Black Hills of South Dakota—a subspecies by name of *P. glauca* var. *albertiana*. Neither the species nor the variety occurs in the mountains farther west or south of these points, as is shown in Fig. 5. The suggested distribution of the species during the steps in the development of the continental ice sheet that is shown in Figs. 6 to 9 attempts to explain the formation of the western subspecies by disjunction in its distribution at climax and also attempts to explain its present absence from the western coastal ranges, where ecological factors are apparently favorable for its existence, by the more rapid formation of glaciers in these highlands so that its southerly progress there was blocked. Furthermore, its present absence from peaks and high ranges of the Rocky Mountains south of Montana suggests that the intervening lowlands were much too dry to permit the further southerly extension of its range.

Since none of the other close associates of this species have a western subspecies, we might postulate less plasticity for the other three forms. Or, because all three are less tolerant than the white spruce, perhaps none were able to reach the favorable highlands and, hence, were confined to the eastern humid half of the country during maximum glaciation.

Tropical forms. At the other extreme of existence, we need to determine whether or not tropical plants were able to persist in southern Florida during the climax of the Wisconsin ice age. If a tropical belt had persisted for any considerable length of time, it would not be unreasonable to expect to find the existence of a considerable number of plant species, or at least subspecies, that are endemic to the region, since it is so isolated

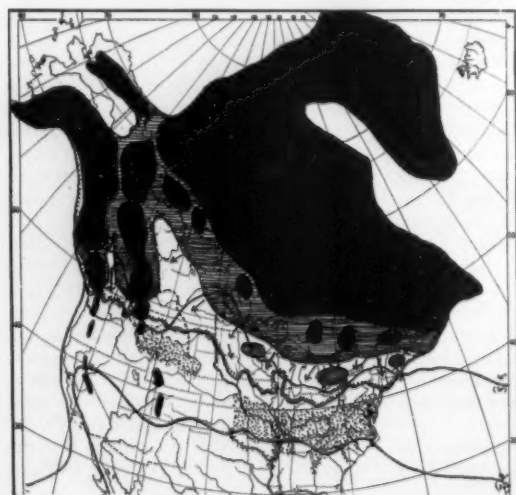


Fig. 9. Stages IV and IVa in the development of the Wisconsin ice sheet. Legend similar to that of Fig. 7; ruled area, new glaciation resulting from additional decrease in temperature of 5°F (a total of 25°); hachured lines, final extent of glaciation resulting from accumulative effects; arrows indicate direction of ice flow.

from other areas of similar climate. However, such is not the case. A study of typical tropical components such as the mangroves, palms, and cycads indicates that all have arrived either by water transport or by way of migrating birds or other animals, from the West Indies or Central America, for all, with minor exceptions, are very broadly distributed. For example, three species of mangroves (*Rhizophora mangle*, *Laguncularia racemosa*, and *Avicennia nitida*) occur along the coasts of southern Florida. These all have peculiar floating seeds that are highly resistant to salt water, and so their extensive range throughout the Caribbean Sea and Gulf of Mexico area is not surprising. Exclusive of *Sabal* species (palmettos), which are fairly cold-tolerant (as indicated by their presence throughout much of the southeast), of nine species of palms that occur in tropical Florida, six are found abundantly in the West Indies. Of the remainder, one (*Rhapidophyllum hystrix*) is found in shaded pine woods as far north as South Carolina and is, therefore, not a good indicator of tropical conditions, while the specific or even varietal status of a second form (*Thrinax keyensis*) is under question. The third species (*Coccothrinax garberi*) alone appears to be truly endemic. As far as the cycads are concerned, only one of the four (*Zamia silvicola*) is confined to the area concerned. Two of the others (*Z. integrifolia* and *Z. unbroosa*) occur in the northern portion of the state as well, while the fourth (*Z. angustifolia*) occurs in the West Indies and is not known to bloom in Florida. Hence, the low endemicity of the tropical flora seems to indicate the complete elimination of suitable climatic factors for its persistence during Wisconsin times.

Evidence from Mexico

In the highlands of the eastern portion of Mexico, extending from Nuevo Leon to Pueblo and into Oaxaca, there are a number of forests in which a species of *Liquidambar* that is indistinguishable from the eastern North American *L. styraciflua* occurs in numbers (see Miranda and Sharp, 28; Hernandez *et al.*, 29; Carlson, 30; Leopold, 31; and Sharp, 32). Such forests occur, furthermore, in isolated patches throughout the state of Chiapas and in the neighboring area of Guatemala. In several instances, there are associated with the sweet gum other species of trees as well as herbs and ferns that likewise are known otherwise only in the eastern United States; they form up to 15 percent of the total plant species in some localities. Tree species that have been reported from these highlands, usually at elevations of about 5000 feet, are as follows: *Acer negundo* (box el-

der) at four Mexican and one Guatemalan localities; *Carpinus caroliniana* (hornbeam) and *Ostrya virginiana* (hop hornbeam) at nearly all stations; *Cercis canadensis* (redbud) at Tamaulipas and Hidalgo only; *Cornus florida* (dogwood) at Orizaba and Veracruz; *Nyssa sylvatica* (tupelo) at five stations in Mexico; *Prunus serotina* (black cherry) at four Mexican and one Guatemalan localities; *Rhus radicans* (poison ivy) at most stations; and *R. aromatica* (aromatic sumac) at Tamaulipas only. Thus it is evident that there is a strong relationship between the eastern Mexican highlands and the corresponding part of the United States, which indicates in a very definite manner the existence of an interconnection of the two regions at a former time. There remains, then, only the problem concerning when the interconnection existed.

If this interconnection were of comparatively recent date, one would expect to find some other of the more common species that predominate in the forests of the southern states. It seems highly significant that none of the species of *Quercus*, *Ulmus*, *Celtis*, *Magnolia*, and *Pinus* that occur in such abundance in east Texas are reported from these areas. While members of these genera are found in the regions under discussion, all are of species that are endemic to Mexico or Central America. Hence, it appears logical that the interconnection of the areas was at a rather remote date and that the eastern species still remaining in the Sierra Madre de Oriental are old, stable forms. That the latter assumption may be true is supported by the distribution of such forms as *Acer negundo* and the paleobotany of *Liquidambar* and *Nyssa*, which are reported from the Upper Cretaceous. *Acer negundo* is found throughout the Rocky Mountain states and along the Pacific Coast as well; here it occurs in a number of varieties, it is true, but all are considered to be conspecific with the eastern form. To me, the evidence appears to point to a time earlier than the Wisconsin during which there was greater rainfall in the eastern portions of northern Mexico and southern Texas, perhaps along with a depression of temperature, that permitted the forests of the southern United States to descend to the regions under discussion. Middle Pleistocene, perhaps the Kansan or Nebraskan period of glaciation, seems strongly indicated, or perhaps even the Pliocene.

In the western side of the country, pines are a characteristic feature of the higher elevations of the Sierra Madre de Occidental. As a whole, pines are incapable of growing in regions with an annual mean of rainfall of less than 20 inches, and the belt of these trees is abruptly interrupted to the north of Mexico by a band of arid land except at higher

elevations (usually above 500 feet) where increased rainfall permits their survival. A study of the members of the genus *Pinus* of this area (see Loock, 33; and Kearney *et al.*, 34) shows that only six species are common to Mexico and the United States. Of these, *Pinus arizonica* (sometimes classified as a variety of *P. ponderosa*), *P. cembroides*, *P. flexilis*, and *P. reflexa* are common to the region of southern Arizona and southwest New Mexico and the western mountains of Mexico, but only as far south as Durango. One other species, *P. leiophylla* (*P. chihuahuana* of some writers), is distributed throughout the whole of western and southern Mexico but occurs also in the southwestern portion of the United States. The sixth form, *P. strobus* var. *chiapensis*, has a distribution that is so disjunctive that little doubt is left concerning the age of the former connection between the range of the species (which now is confined to the northeastern states and along the Allegheny mountains) and that of the variety (which is known only in southern Mexico). To me, all the other distributions seem to point to an increase of rainfall for the region of southern Arizona and southwest New Mexico into the western ranges of Mexico, but only as far south as southern Durango, at which time the first four species entered Mexico from the north, while *P. leiophylla* entered the United States from the south, probably at the maximum of the Wisconsin glaciation. To the north, the limitations on the distributions of all these species indicate unfavorable conditions for the region in between the mountain ranges of northern Arizona and those to the south; this is confirmed in part by the distribution of such northern elements as *Juniperus scopularum*, which is found at similar elevations as the pines listed in this paragraph but in the more northern portion of the Rocky Mountains.

In the great central region of northern Mexico, nothing could be found that indicates a moister climate than that which now prevails; this, considering the high mountain ranges that border it on almost all sides (which existed at least as far back as the Pliocene) is not surprising.

Hence, there appears to be no valid basis for any taxonomist or zoogeographer to assume, as has occasionally been the case in the past, that the biota of all of the continent was funneled, with the advance of the ice sheet, through Mexico into Central America, where hybridization would take place. Were this the case, there would certainly exist many more elements common to the east and west parts both of Mexico and of the United States as well as more elements common to these two nations. On the basis of the floral evidence examined here, it may be assumed only that the biota extended farther south only on the west coast, and

there only to the lower border of Durango. In the east and central portions, no southerly extension of ranges occurred during the Wisconsin period.

Life Zones of the Wisconsin Era

If it is true today that the boundaries of the life zones and biotic provinces cannot be too sharply drawn, it would seem that this is doubly true for the last period of maximum glaciation. At least in the eastern half of the continent all available data point to a curious intermingling of boreal elements such as spruce with the present floral components, even in the southernmost parts of the United States, except southern Florida. However, we do not need to suppose that the presence of these northern types to the extent of 10 percent indicates that the whole region was transformed, say from the Lower Austral to the Hudsonian life zone. Since white spruce can be grown in cultivation many hundreds of miles south of its present range by supplying sufficient moisture, it might well be that it was enabled to extend its range into the southern area both by a somewhat lowered mean temperature and by an increase in rainfall. Furthermore, all the evidence for the presence of such cold-loving species in warmer regions is supplied by alluvial deposits and by fossil pollen derived from peat deposits, so

that it could easily be assumed that these trees grew primarily along the banks of streams and in bogs (as they do today in the western part of their range, it will be remembered), leaving the uplands to the present vegetative types. Thus we may be fairly certain that there never existed great extensive evergreen forests in the eastern part of the country like those of northeastern Canada, at least not until after deglaciation had begun. Then—with the combination of general flooding, long-frozen soil, and poor deep drainage—white and black spruce, tamarack, and similar species, which are especially adapted for such conditions, were able to follow the retreating ice sheet more closely than were the broad-leaved trees. But that was postmaximum.

Beginning at the area adjacent to the ice sheet, we would find, because of the probably permanently frozen soil, a tundra zone, possibly replete with musk ox and reindeer, at least in the central stretches, bordered to the south at most by a very narrow border of spruce forests where frozen soil and poor drainage would not permit hardwoods to grow. Southward, then, in order, we could postulate Canadian, Transition, Upper Austral, and Lower Austral zones similar to those of today but necessarily narrower. In addition, in all probability they were more poorly defined, not only by the more southerly extension of northern forms, but possibly also by an extension

to the north of some southern species made possible by the more abundant moisture. Because of the proximity of the ice sheet, severe cold waves were in all likelihood experienced farther south than at present and at closer intervals, so that tropical forms could not exist except possibly where the Gulf Stream could provide a moderating influence as in the lower Keys, if they existed at that time. However, I do not know of any evidence for even this latter supposition; hence, a Tropical zone is not shown on the map.

In the western half of the continent, where high cold mountain peaks tower above hot arid or semiarid regions, the picture is highly complex. In the southern half of the area, the present life zones, as pointed out by Antevy, were depressed at least to a depth of one such zone by the decrease in mean temperature. Simultaneously, the increase of rainfall for this same region, indicated by that same worker but overlooked by him for life-zone consideration, would probably permit much the same sort of intermingling of biotic types as is found in the east, with such boreal forms as Douglas fir descending to low levels along streams and in the canyons and possibly forming a largely continuous network over much of the Rocky Mountain and north coastal area. However, as we have seen before, there likely existed a drier belt across central Arizona and on the basis of the distribution of the Rocky Mountain form

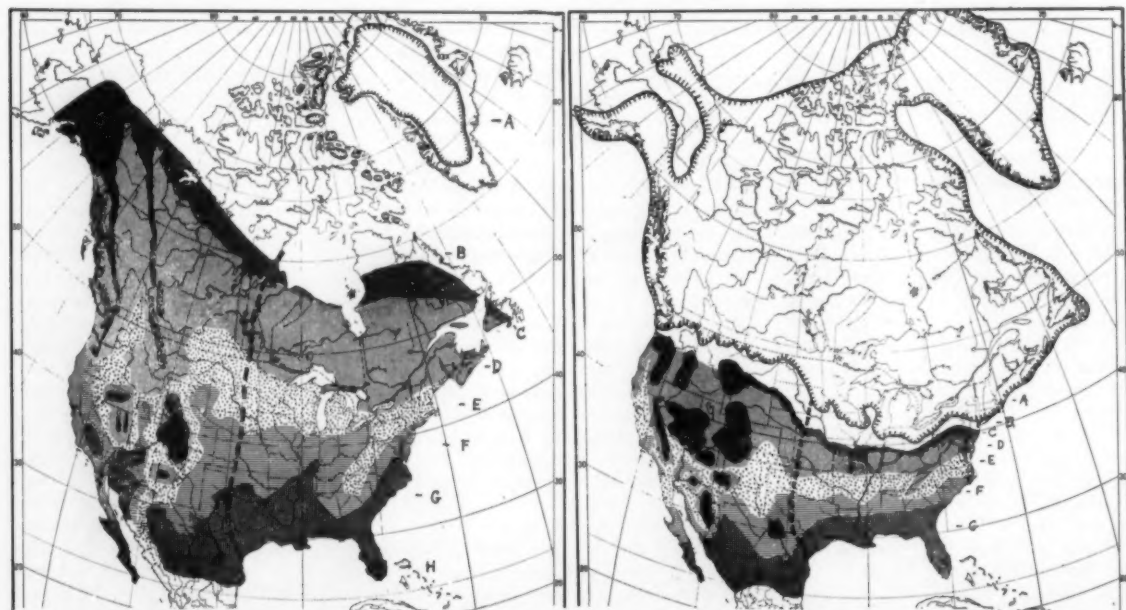


Fig. 10 (left). Present life zones (simplified from Merriam). (A) Arctic glaciation, (B) tundra, (C) Hudsonian, (D) Canadian, (E) Transitional, (F) Upper Austral, (G) Lower Austral, (H) Tropical. The heavy broken line marks the limit of 20-inch mean annual rainfall. Fig. 11 (right). Hypothetical life zones of the Wisconsin ice age. Legend same as that for Fig. 10.

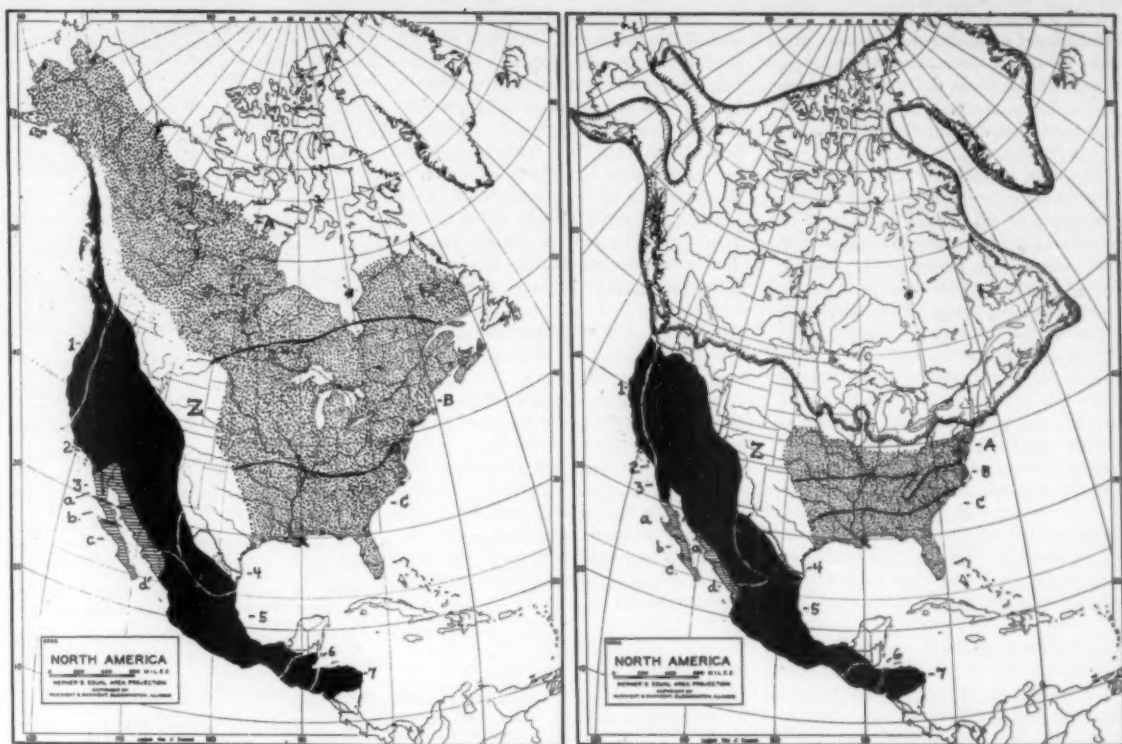


Fig. 12 (left). Present distribution of the genus *Colaptes* in North America. Stippled area, range of *C. auratus*: (A) *C. a. borealis*, (B) *C. a. luteus*, (C) *C. a. auratus*. Black area, range of *C. cafer*: (1) *C. c. cafer*, (2) *C. c. collaris*, (3) *C. c. martirensis*, (4) *C. c. nanus*, (5) *C. c. mexicanus*, (6) *C. c. mexicanoides*, (7) *C. c. pinicolus*. White area (Z), zone of hybridization between *C. auratus* and *C. cafer*. Ruled area, *C. chrysoides*: (a) *C. c. mearnsi*, (b) *C. c. brunnescens*, (c) *C. c. chrysoides*, (d) *C. c. tenebrosus*. Fig. 13 (right). Hypothetical distribution of North American *Colaptes* during the Wisconsin maximum. Legend same as that in Fig. 12.

of the white spruce, a similar disruptive factor across central Wyoming. There is nothing to warrant an assumption that annual rainfall increased in the Basin and Range region to as much as 20 inches, so that the Sierra Nevada and southern coastal range belts were not interconnected with the Rocky Mountain biota.

Life zones, which ignore historical influences, are particularly unsatisfactory in the western states, but so are the biotic provinces of Dice, which exclude elevational ecological factors. Selection between these two possibilities then becomes a difficult matter, but because ecological considerations appear to be more important, I have attempted to reconstruct them, using all available data, for the glacial period under discussion (see Figs. 10 and 11).

Effects on Speciation

In general, it would seem, despite the extreme displacement of the range of many organisms, especially of those liv-

ing in the more northerly reaches of the continent, that there was but slight effect on speciation among the North American biota as a result of the Wisconsin glaciation. It is especially apparent that eastern and western flora and fauna never became intermingled and that there was no funneling effect into Mexico and Central America. Possibly this continued isolation between the two sectors was brought about in part by the oblique position of the Canadian Rocky Mountains, which formed an effective barrier between southerly migrating species and the western United States. Probably equally effective also was the semiarid grassland area of the Central States. Nevertheless, several items of some general application to speciation problem may be indicated.

Of these, one, of interest chiefly because of its time implications, concerns the musk ox. As has been shown in a previous section, these animals are known to have lived in the tundra area just below the border of the ice sheet during Wisconsin times; they have assumed their present distribution in the 12,000 years since the melting of the glaciation. It

seems extremely unlikely that the three subspecies now extant could have remained as isolated populations during their migration south and north as the glaciation advanced and finally receded, nor can any facts to found that support such isolation during the glacial maximum. Hence, it appears most likely that this subspeciation has occurred since the present ranges were assumed. On the one hand, this process of subspeciation has been speeded, in all likelihood, by the tendency of the animal to remain in herds and by the difficulty of the terrain in which it lives; on the other hand, it has been retarded by the relatively low biotic potential of the species.

As another example of subspeciation resulting from the last glacial period, the case of *Picea glauca* may be cited. The present distribution of its sole subspecies, *P. g. albertiana*, in the northern Rocky Mountains and in a few scattered situations as far east as the Black Hills, seems to point to isolation of an eastern and western population during the Wisconsin maximum. In this case, however, unlike the case of the musk ox, there can be

shown no irrefutable evidence that this isolation did not occur during some previous period of glaciation. Nevertheless, in view of the slight differences between the two forms, there is no real reason not to believe that the isolation occurred as here indicated.

The case of *Colaptes* (35) in North America is even more subject to question, although it would appear that a zone of hybridization was present in the past as now. Hence, *C. auratus*, the yellow-shafted flicker, was confined to the eastern states during maximum development of the last ice age, with the ranges of its present three subspecies condensed (Figs. 12 and 13) in response to the narrowing of the life zones. Neither the supposed past nor the present actual distribution provides any basis for the placement of a date on the origin of the three forms. Nor does the presence of a fourth subspecies in Cuba and a fifth on Grand Cayman Island aid toward this end. All that can be gathered is that the subspeciation came about as a result of temperature differences in their respective areas. In the west, the subspecies of the red-shafted flicker, *C. cafer*, similarly provide little evidence of the effects of the last ice sheet on speciation. It may be proposed that the Pacific Coast form, *C. cafer cafer*, was forced southward, and that the widely distributed *C. c. collaris* was enabled to penetrate into northern Baja California and onto the adjacent coastal islands as a result of the increased rainfall suggested for the region. If such were actually the case, then it would follow that the subspecies *C. c. sedentarius*, which is found on Santa Cruz Island, the now extinct *C. c. rufipileus*, which was

formerly resident on Guadalupe Island, and *C. c. martirensis*, which is still extant on the western slopes of the mountain ranges in northern Baja California, have arisen as a result of isolation since the glacier's retreat—that is, during the last 12,000 years. Now these three forms are very similar to *collaris*, whereas the southern race of the species, *C. c. mexicanoides*, is most closely allied to the nymotypical form of the northwest coast. This would suggest that the species originally was similar in body size and in coloration to *C. c. cafer*, and that *collaris*, *mexicanus*, and *mexicanoides* arose before Wisconsin times, perhaps during an interglacial period.

By following similar lines of reasoning, one could analyze speciation of all the innumerable members of the North American biota, but space will not permit further discussion here. In closing, I would like to repeat, however, that the effects of both the temperature change and the altered precipitation pattern must be borne in mind whenever such analyses are attempted.

References and Notes

1. For their assistance in providing literature and references, I take pleasure in acknowledging my indebtedness to W. Armstrong Price, oceanography department, to Bruce Zobel, Forest Genetics Laboratory, and to John Merkle, biology department, all at the A. and M. College of Texas. I am under special obligation to Chester Rowell, also of the biology department, for his generosity in making available his detailed knowledge of the flora of Mexico, and to H. Albert Brown, of the meteorology department at the University of Chicago, for his helpfulness with the climatic portion of this paper.
2. B. Haurwitz and J. M. Austin, *Climatology* (McGraw-Hill, New York, 1944).
3. "Glacial Map of North America," *Geol. Soc. Amer. Spec. Paper* 60 (1945).
4. E. Antevy, *J. Geol.* 62, 182 (1954).
5. —, *ibid.* 61, 195 (1953).
6. F. Klute, *Z. Gletscherk. Berlin* 16, 70 (1928); O. E. Meinzer, *Bull. Geol. Soc. Amer.* 33, 541 (1922); S. Endo, *Am. J. Sci.* 25, 179 (1933).
7. H. Meyer, *Geograph. Z.* 10, 593 (1904).
8. R. F. Flint, *Glacial Geology and the Pleistocene Epoch* (Wiley, New York, 1947).
9. L. D. Potter, *Ecology* 28, 396 (1947).
10. H. D. Darlington, *Botan. Gaz.* 104, 371 (1943).
11. E. S. Deevey, *Am. J. Sci.* 240, 233 (1942).
12. —, *ibid.* 241, 717 (1953).
13. G. D. Fuller, *Ecology* 16, 473 (1935).
14. G. H. Lane, *Iowa Geol. Survey Ann. Rept.* 37, 233 (1941).
15. W. P. McCulloch, *Ecology* 20, 264 (1939).
16. C. O. Rosendahl, *ibid.* 29, 284 (1948).
17. P. B. Sears, *Ohio J. Sci.* 30, 205 (1930); *Ecology* 12, 650 (1931); *Am. Anthropol.* 34, 610 (1932); *Bull. Am. Meteorol. Soc.* 19, 177 (1938); *Botan. Gaz.* 103, 751 (1952); *Ecology* 29, 326 (1948).
18. D. C. Frey, *Ecology* 32, 518 (1951).
19. M. F. Buell, *Torrey Bot. Club* 43, 117 (1945).
20. J. E. Potzger, *Butler Univ. Botan. Studies* 7, 182 (1945).
21. J. H. Davis, *Florida Geol. Survey Geol. Bull.* No. 30 (1946).
22. C. A. Brown, *Louisiana Dept. Conservation Geol. Bull.* 12, 59 (1938).
23. J. E. Potzger and B. C. Tharp, *Ecology* 28, 274 (1947); 35, 462 (1954).
24. J. A. Allen, *Mem. Am. Museum Nat. Hist.* ser. 2, 1, 101 (1913).
25. G. M. Allen, *Am. Committee Intern. Wild Life Protection Publ.* 11 (1942).
26. O. P. Hay, *Carnegie Inst. Wash. Publ. No.* 322A (1924); *Carnegie Inst. Wash. Publ. No.* 322B (1927).
27. W. M. Harlow and E. S. Harrar, *Textbook of Dendrology* (McGraw-Hill, New York, 1941).
28. F. Miranda and A. J. Sharp, *Ecology* 31, 313 (1950).
29. E. Hernandez X. et al., *Bull. Torrey Bot. Club* 78, 458 (1951).
30. M. C. Carlson, *ibid.* 81, 397 (1954).
31. A. S. Leopold, *Ecology* 31, 507 (1950).
32. A. J. Sharp, *Rev. soc. mex. hist. nat.* 7, 35 (1946); A. J. Sharp and E. Hernandez X., *Bot. Biol. Univ. Puebla* 4, No. 11-12, 13 (1945).
33. E. E. M. Loock, *Union S. Afr. Dept. Forestry Bull.* 35 (1950).
34. T. H. Kearney et al., *Arizona Flora* (Univ. of California Press, Berkeley, 1951).
35. J. A. Allen, *Bull. Am. Museum Nat. Hist.* 4, 21 (1892).

"... Dr. Priestley you tell me continues his experiments with success. We make daily great improvements in natural, there is one I wish to see in moral philosophy; the discovery of a plan, that would induce & oblige nations to settle their disputes without first cutting one another's throats. When will human reason be sufficiently improv'd to see the advantage of this! When will we be convinc'd that even successful wars at length become misfortunes to those who unjustly commenced them, & who triumph'd blindly in their success, not seeing all its consequences."—BENJAMIN FRANKLIN to Richard Price, Passy, 6 Feb. 1780.

News of Science

NSF Institutes for Science and Mathematics Teachers

Because of the national importance of maintaining scientific and technical leadership, and in recognition of the key role our college and high-school teachers play in increasing our technical potential, the National Science Foundation will continue its program of summer institutes for high-school and college teachers. In addition, the foundation will support two experimental academic-year institutes designed to assist colleges and universities in their efforts to improve science subject matter training programs for high-school teachers of science and mathematics. Both programs are directed toward strengthening the capacity of our teachers to motivate students to consider careers in science and engineering by increasing the students' comprehension of basic science and mathematics.

Twenty grants have been made to institutions for the support of summer institutes for college and high-school science and mathematics teachers. The institutes planned for the summer of 1956 will enlarge the experimental program that was initiated in 1953 and described previously [*Science* 121, 414 (25 Mar. 1955)]. Now in its fourth consecutive year, the program will provide opportunities for staff members of colleges and high schools to attend courses in the subject matter of science and mathematics that are especially designed for teachers and that are conducted by faculty members noted for competence in their fields and for skill in presentation.

The grants provide for financial assistance to more than 1000 participating teachers, approximately 50 at each institute, and for additional allowances for dependents. Institutions receiving grants, their institute designs, and persons to whom inquiries or applications may be addressed are as follows:

Alabama College, 6 weeks, for high-school teachers of science; P. C. Bailey, Department of Biology, Alabama College, Montevallo.

American Society for Engineering Education, at the Argonne National Laboratory, Chicago, Ill., 8 weeks, nuclear energy, for staff members from engineering colleges; Donald H. Loughridge,

Dean of Engineering, Northwestern University, Evanston, Ill.

American University, 6 weeks, for high-school teachers of the physical sciences; Keith C. Johnson, Science Supervisor, D.C. Public Schools, Woodrow Wilson High School, Washington, D.C.

University of Arkansas, 6 weeks, for high-school teachers of the natural sciences; L. F. Bailey, Department of Botany, University of Arkansas, Fayetteville.

Botanical Society of America, at Cornell University, 6 weeks, for college teachers of botany; Harlan P. Banks, Department of Botany, Cornell University, Ithaca, N.Y.

Indiana University, 4 weeks, for college teachers of chemistry; Robert B. Fischer, Department of Chemistry, Indiana University, Bloomington.

Indiana University, 6 weeks, for high-school teachers of biology; Shelby D. Gerking, Department of Zoology, Indiana University, Bloomington.

Iowa State Teachers College, 6 weeks, for high-school teachers of mathematics; Henry Van Engen, Department of Mathematics, Iowa State Teachers College, Cedar Falls.

Marshall College, 6 weeks, for high-school teachers of the physical sciences; Donald C. Martin, Department of Physics, Marshall College, Huntington, W.Va.

University of Michigan, 8 weeks, for college teachers of mathematics; T. H. Hildebrandt, Department of Mathematics, University of Michigan, Ann Arbor.

Montana State College, 5 weeks, for high-school and college teachers of chemistry; L. O. Binder, Jr., Department of Chemistry, Montana State College, Bozeman.

Oak Ridge Institute of Nuclear Studies, two institutes—4 weeks each—one for high school teachers and one for college teachers of physical science; Ralph T. Overman, Special Training Division, Oak Ridge Institute of Nuclear Studies, Inc., Box 117, Oak Ridge, Tenn.

Oregon State College, 4 weeks, for college teachers of chemistry; W. H. Slabaugh, Department of Chemistry, Oregon State College, Corvallis.

Pennsylvania State University, 6 weeks, for high-school teachers of science; William H. Powers, Arts and Science Extension,

Pennsylvania State University, University Park.

University of Rochester, 6 weeks, for high-school teachers of physics; Howard R. Anderson, Dean of University School, University of Rochester, Rochester, N.Y.

University of Utah, 5 weeks, for high-school and college teachers of biology; Loren C. Petry, Department of Botany, University of Missouri, Columbia.

Wesleyan University, 6 weeks, for high-school teachers of science; H. B. Goodrich, Department of Biology, Wesleyan University, Middletown, Conn.

Williams College, 6 weeks, for high-school and college teachers of mathematics; Donald E. Richmond, Department of Mathematics, Williams College, Williamstown, Mass.

Wisconsin State College at Eau Claire, 4 weeks, astronomy for staff members of teacher training colleges; William A. Calder, Bradley Observatory, Agnes Scott College, Decatur, Ga.

University of Wyoming, 5 weeks, for high-school and college teachers of physics; Marsh W. White, Department of Physics, Pennsylvania State University, University Park.

The National Science Foundation plans to continue the summer institutes program in 1957. Proposals from colleges, universities, and professional societies for support of 1957 summer institutes should be received by the foundation not later than 1 Sept. 1956. Preliminary inquiries and final proposals should be addressed to the Program Director for Education in the Sciences, Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D.C.

Grants for the experimental academic-year institutes for high-school science teachers have been made to the University of Wisconsin and Oklahoma A. and M. College. Both of these institutes will offer courses of study in science and mathematics that are planned cooperatively by the members of the science, mathematics, and education departments in the host institution. In each institute there will be provisions for adapting the curriculum to individual needs, and the courses designed specifically for high-school teachers may be applied as partial fulfillment of the requirements for a master's degree. The grants will provide stipends of \$3000 to 50 teachers in each institute. Additional allowances for dependents will also be provided.

These two experimental institutes will be conducted in the academic year 1956-57. The experience gained in them will be used in planning a somewhat larger program for the academic year 1957-58. Inquiries regarding the institute at Oklahoma A. and M. College should be addressed to Prof. James H. Zant, Department of Mathematics, Oklahoma A.

and M. College, Stillwater. Inquiries regarding the institute at the University of Wisconsin should be addressed to Prof. Harvey Sorum, Department of Chemistry, University of Wisconsin, Madison.

HARRY C. KELLY
National Science Foundation,
Washington 25, D.C.

New AAAS Associate Society

The Council of American Bioanalysts was formed with the primary purpose of bringing together people who direct, perform, or teach analyses as they are applied to medical laboratory procedure or related fields. The term *bioanalyst* was coined from the prefix *bio* and the word *analyst* to describe an individual who by training and competence is capable of directing or teaching analytical procedure involving the biological sciences.

While the first members were drawn from state clinical laboratory associations, provision for membership was made for other scientific workers with identical interest. Accordingly, laboratory officers in the armed forces, technical laboratorians from public health laboratories, and university professors teaching curricula in these areas have become members.

The administrative organization consists of a national board of directors and five regional boards. The officers serve in dual capacities as national and regional representatives. Scientific activities of the society are concentrated in an internal council known as the scientific council. Officers to staff this are elected, and some of them serve simultaneously on the national board. All meetings, evaluation studies, publication of scientific journals, and studies of the utility of courses offered for academic instruction are governed through this council.

The most important project undertaken so far has been a general evaluation of laboratory routine and methods. The program is divided into two general categories; one consists of 25 laboratories selected on the basis of previous performance; the second consists of an indeterminate number of laboratories that accept specimens to check routine procedures within their institutions. The first group acts as a control unit for the preparation of samples issued to the second, and in addition conducts evaluation of specific methods or techniques. This entire program has been under the direction of Nell Hollinger, an associate professor in the School of Public Health at the University of California, Berkeley.

Publication of a quarterly journal, *Abstracts of Bioanalytic Technology*, has provided coverage of technical, bioanalytical literature in a manner not previ-

ously offered by other publications. Under the editorial direction of H. E. MacDaniels of the Illinois State Department of Public Health, a group of editors scattered throughout the United States scan and select articles. These are professionally abstracted by the Crerar Library staff in Chicago and published within 3 months of their original appearance.

Emphasis has been placed on regional meetings within a geographic area small enough to allow the greatest number to participate. The society has established a policy of inviting the attendance at meetings of members of all other scientific societies within the area concerned. National meetings are usually held in conjunction with one of the regional meetings.

The past two presidents have been Donald Abel of Chicago and William Reich of Walnut Creek, Calif. The present president is Marion Dooley, director of a clinical laboratory in Dallas, Tex. The president-elect is Thomas S. Hosty, director of the Alabama State Department of Public Health Laboratory at Montgomery.

In a special tribute Margaret Beattie, an outstanding educator and a professor in the School of Public Health at the University of California, Berkeley, was made an honorary member of the council. A lecture series named in her honor, the Margaret Beattie lecture, was created as an annual event. The inaugural paper was presented in January 1955 by Maxwell S. Wintrobe, professor of medicine of the University of Utah. The second will be delivered on 4 Feb. in San Francisco, by Linus Pauling, Nobel laureate in chemistry and professor of chemistry at California Institute of Technology.

The council engages in a number of other programs designed for the benefit of its members. Notable among these is an insurance program for those in applied bioanalysis that provides malpractice coverage. Another is the preparation of a series of handbooks that are being assembled for future publication under the general title "The handbook of bioanalytic technology." Still another is a program of improving educational facilities for present and future members.

LUCIEN D. HERTERT
Executive Secretary
490 Post St., San Francisco 2, Calif.

Radioisotope Distribution

The Atomic Energy Commission announced issuance on 11 Jan. of a revised regulation, "Licensing of byproduct material," that removes certain restrictions on the sale of radioisotopes abroad and simplifies procedures governing domestic distribution. The regulation is effective

on 10 Feb.; it replaces the existing radioisotopes-distribution regulation, which was first issued in 1951.

The revised regulation makes more conveniently available to scientists in other countries radioactive materials for use in medicine, agriculture, industry, and the physical sciences. Research groups abroad may now deal directly with production and distribution centers in this country. In the United States the revision will help American research workers and the growing body of radioisotope users by raising the limit on quantities of radioactive materials available to each user under general license.

In issuing the revised regulation, the AEC said that its usual practice of publishing a proposed regulation and inviting comment was not followed because the revisions made are for the most part designed to remove certain existing restrictions and to clarify present provisions, and not to impose additional requirements on licensees or applicants. In connection with consideration of further amendments, interested persons may submit written comments and suggestions to the U.S. Atomic Energy Commission, Washington 25, D.C., attention the Director, Division of Civilian Application.

Salk Vaccine in Massachusetts

■ A report on the effectiveness of the Salk vaccine in last summer's poliomyelitis epidemic in Massachusetts has been compiled by the Massachusetts Department of Public Health under a grant from the National Foundation for Infantile Paralysis. The report appeared in the 19 Jan. issue of the *New England Journal of Medicine*. It states that one injection was 60 percent effective against all paralytic poliomyelitis, 66 percent effective against bulbospinal poliomyelitis, and 65 percent effective against bulbar poliomyelitis.

(A U.S. Public Health Service analysis of paralytic poliomyelitis in 11 other states, made on 15 Nov., showed vaccine effectiveness levels for 1955 ranging from 55 to 91 percent, and averaging 76 percent. Last April's report by Thomas Francis, Jr., on the vaccine used in the 1954 field trials gave an effectiveness of from 60 to 90 percent for children who had received three injections in a 5-week period.)

The Massachusetts report said that "no conclusions should be drawn" from the figures on results of more than one injection of vaccine, because relatively few cases were tabulated. But the effectiveness for two or more shots was estimated at 69 percent against all paralytic poliomyelitis.

This means that 157 paralytic cases

occurred per 100,000 unvaccinated children, whereas 21 paralytic cases occurred per 100,000 children who had received only one shot. Among 4658 youngsters who received three injections of vaccine during the 1954 field trials, plus a booster shot in 1955, there was only one case of paralytic poliomyelitis.

In a comparison of the Massachusetts one-shot experience with the experience with children who had received three injections in the 1954 field trials, the report said, "It is remarkable that one dose could have approached so closely the value of three doses, particularly in an epidemic situation. It would seem to indicate that the vaccine used in Massachusetts in 1955 was a particularly effective one."

The report noted that the "unprecedented" Massachusetts epidemic was due almost entirely to type I poliomyelitis. It was against this type of virus that the 1954 field trial vaccine was least effective.

The Massachusetts survey was directed by Alton S. Pope, former deputy commissioner of the State Department of Public Health. A total of 3608 cases were studied in preparing the report. Study populations were obtained from school census reports in 351 Massachusetts cities and towns. The authors of the report describe it as preliminary; a further paper will contain additional information and figures that have not yet been analyzed.

Grasshoppers on the Rangelands

A recent survey by the U.S. Department of Agriculture indicates that the 1956 grasshopper problem on western rangelands will be more than three times more serious than in 1955. The survey indicated that grasshopper populations will occur in 1956 on more than 20 million rangeland acres in 16 states, compared with the 6 million acres given in the preliminary estimate for 1955.

The states involved are Arizona, California, Colorado, Idaho, Kansas, Missouri, Montana, Nebraska, Nevada, New Mexico, Oklahoma, Oregon, Texas, Utah, Washington, and Wyoming. In 1955, almost 1,650,000 acres of rangeland in 11 states were treated with insecticides to control grasshoppers.

Next spring the threatened areas will be resurveyed to find what toll predators, parasites, diseases, and weather take over the winter of the potential insect population. Final plans for 1956 control work will be based on the findings of this study.

In these grasshopper surveys, investigators count the actual number of insects per square yard at sample stops in suspected areas. Later in the fall, they re-

turn to check whether the outlook remains the same or whether a shifting of adult egg-laying insects has changed the forecast.

The surveyors shovel a measured square foot of soil into a sifting screen, or scrape away plants and dig into the soil, to expose and count grasshopper egg pods. From these counts the coming year's infestations are rated, and the data are used to make up maps and estimates of the potential infestation for the following year.

News Briefs

■ The French Physical Society held a special meeting to celebrate the discovery of artificial radioactivity by F. Joliot-Curie and his wife in 1934. Four commemorative papers that were delivered were published in the October 1955 issue of *Le Journal de Physique*: "The historical aspect of the discovery of artificial radioactivity," by S. Rosenblum, research director, C.N.R.S.; "Artificial radioactivity and physics," by O. R. Frisch, Cambridge; "Artificial radioactivity and chemistry," by F. A. Paneth, Max-Planck Institute, Mainz; "Artificial radioactivity and biology," by M. Tubiana, Institute Gustave Roussy, Villejuif.

■ A mutual assistance agreement between India and the United Kingdom for the development of peaceful uses of atomic energy was announced late in December by the United Kingdom Atomic Energy Authority. The statement issued by the Atomic Energy Authority states:

"Discussion between the United Kingdom Atomic Energy Authority and the Indian Department of Atomic Energy have led to the conclusion of an agreement which ensures that there shall be close co-operation and mutual assistance between the Authority and the Department in the promotion and development of the peaceful uses of atomic energy. The agreement provides for the Authority and the Department to arrange for members of their staffs to consult and work together on mutually agreed topics. In furtherance of this agreement the United Kingdom Atomic Energy Authority will provide the Indian Department of Atomic Energy with enriched uranium fuel elements for a swimming pool reactor now under construction and a high flux research reactor which may be built at a later date."

■ An experimental electric train fitted with a germanium rectifier—which converts the alternating current picked up from an overhead wire to direct current for the traction motors—has completed

successful trials on the Lancaster-Morecambe-Heysham line of British Railways. It is believed to be the first ever to use such an installation. The manufacturers of the rectifier (British Thomson-Houston Company, Ltd., Rugby, England) claim that it is more efficient and reliable than the mercury-arc rectifier.

■ A new agricultural fungus disease, previously unknown in the United States, has been discovered in Mississippi, according to the U.S. Department of Agriculture and the Mississippi Agricultural Experiment Station. The disease, downy-mildew of crimson clover, is caused by a fungus, *Peronospora viciae*, which does considerable damage to crimson clover in sections of Europe. The disease has not yet become damaging in this country.

Leaves of infected crimson clover appear yellowish gray to purple from above, and are often curled. The lower surface of the leaves is coated with downy fuzz which becomes violet-colored after a period of time.

Scientists in the News

JOHN F. FULTON, Sterling professor of the history of medicine at Yale University and for many years chairman of the department of physiology, was honored on 14 Jan. at a reception and dinner given to mark his completion of 25 years of service as Sterling professor.

Fulton's work in neurophysiology has outlined basic concepts of the workings of the brain. He is also credited with major responsibility for the development of Yale's medical history library. A special issue of the *Yale Journal of Biology and Medicine*, dedicated to Fulton, was presented to him.

PHILIP HERSHKOVITZ, associate curator of mammals at Chicago Natural History Museum, has been appointed curator. He succeeds COLIN C. SANBORN, who retired 31 Dec. because of ill health.

EDWARD C. BULLARD, director of the National Physical Laboratory, Department of Scientific and Industrial Research, London, England, resigned on 31 Dec.

RUBEN F. METTLER, director of advanced systems planning at the Ramo-Wooldridge Corporation, Los Angeles, Calif., has been named one of the "Ten Outstanding Young Men of 1955" by the U.S. Junior Chamber of Commerce. Mettler was honored for "contributions in rocket fire control developments and classified military electronics."

EVARTS A. GRAHAM, Bixby professor emeritus of surgery at Washington University (St. Louis), has been named recipient of the 1955 award for service to medicine by the alumni association of the St. Louis College of Pharmacy and Allied Sciences. Graham was cited for his own studies and for stimulating research on the relationship between tobacco smoking and lung cancer. The presentation will be made at the alumni association's annual awards dinner on 26 Feb.

GUNNER THORSON of Copenhagen, Denmark, will be giving a series of lectures at the University of Miami Marine Laboratory, Coral Gables, Fla., between 2 and 23 Mar. There will be a special seminar on marine ecology on 21 Mar.

GEORGE GAMOW, professor of theoretical physics at George Washington University, has been granted a leave of absence for the spring semester in order to conduct research at Convair, Inc., San Diego, Calif.

V. F. WEISSKOPF, professor of physics at the Massachusetts Institute of Technology, will give a course at Harvard University on the theory of nuclear structure as Morris Loeb lecturer in residence for the spring term.

JEWELL M. GARRELT, bridge engineer and Renwick professor of civil engineering at Columbia University, received on 12 Jan. one of the Great Teacher awards of the university's Society of Older Graduates.

SVEN V. FURBERG, associate professor of physical chemistry at the University of Bergen, Bergen, Norway, will arrive soon in Uruguay, where he will assist in crystallography research at the School of Engineering of the University of Montevideo. His trip is being sponsored by UNESCO.

WILLIAM G. NEWTON, formerly with the General Aniline and Film Corporation of Linden, N.J., has been appointed chief industrial engineer of the Beckman Division of Beckman Instruments, Inc.

HENRY TAUBE, professor of chemistry at the University of Chicago, has been appointed chairman of the department. He succeeds Warren C. Johnson, who was named dean of the division of the physical sciences last October.

An authority in the field of physical organic chemistry, Taube was the first recipient, in April 1955, of the American Chemical Society award for nuclear applications in chemistry.

A. G. HOGAN has retired as chairman of the department of agricultural chemistry at the University of Missouri. He is succeeded by MERLE E. MUHRER.

WALTER H. BEISLER has taken a 2-year leave of absence from the University of Florida faculty to participate in an educational project being conducted in Lahore, Pakistan; the project is being carried out by the State College of Washington for the University of Punjab under the sponsorship of the U.S. International Cooperation Administration.

C. E. KENNETH MEES retired on 15 Nov. 1955 as vice president in charge of research for the Eastman Kodak Company. He has taken up permanent residence at his home in Honolulu, Hawaii, but he continues as a member of the board of directors.

Mees, who was born in England, did not become interested in photographic science until after he entered University College, London. A short time previously he had met S. E. Sheppard. Together, using apparatus they built themselves, Mees and Sheppard repeated and extended the work of Hurter and Driffield on the basic principles of photographic exposure and development. The results were submitted as theses for the B.Sc. degree by research, the first and last time such a degree was granted by London University.

Following the granting of the degrees to them in 1903, the two students continued their work on the theory of the photographic process and in 1906 published their researches jointly as a book, *Investigations on the Theory of the Photographic Process*. On the basis of this work, each was granted the doctor of science degree.

In 1906, on the advice of his professor, William Ramsay, he joined the small photographic firm of Wratten and Wainwright, Ltd., Croydon, as a partner and joint managing director. For 6 years Mees worked at Wratten and Wainwright. He studied photographic sensitizing and the spectrophotometric characteristics of dyes; he worked out methods for the manufacture of light filters and safelights, and for special plates for photoengravers and spectroscopists; and he conducted research on the resolving power of photographic materials.

Then in 1912, at Eastman's invitation, he joined the Eastman Kodak Company and went to Rochester, N.Y., to organize and direct a research laboratory. During the 44 years in which Mees was con-

cerned with the operation of the laboratory at Kodak Park, he made many contributions to the development of the science of photography and to the application of science to industry. The research program has resulted in the introduction of new photographic materials for the amateur and the professional, the industrial worker and the scientist.

Among the significant advances that have taken place under Mees' direction are (i) the founding in 1917 of the first school of instruction in aerial photography, (ii) the establishment in the laboratory in 1918 of a department for the manufacture of synthetic organic chemicals when the supply of such products from Germany was cut off during World War I, (iii) the organization of a department in 1919 for the development of photographic apparatus, (iv) the establishment in 1931 of a department of emulsion research that has made contributions to the knowledge of emulsion manufacture, and (v) the establishment in 1934 of a department in the laboratory to carry out research on cellulose ester yarn and plastics for the Tennessee Eastman Company.

Mees was named a director of the Kodak Company in 1923 and was elected vice president in charge of research and development in 1934. In the last half-century, Mees has done much writing, lecturing and traveling. He has published nine books and some 160 scientific articles and pamphlets. Best known of his books is *The Theory of the Photographic Process*, published in 1942 and revised in 1954. Mees is a fellow of the Royal Society of London, a member of the American Philosophical Society, and a member of the National Academy of Sciences.

ERNEST E. CHARLTON of the General Electric Research Laboratory, Schenectady, N.Y., an authority on high-voltage and x-ray devices, retired on 31 Jan. after more than 35 years of service. Charlton's career has included 26 years as manager of the laboratory's x-ray section, in which position he directed the development of a large number of devices, including the million-volt x-ray unit now extensively used in hospitals for cancer treatment and in industry for the x-raying of metal parts. The 1-Mev x-ray generator, a source of high-energy electron beams used in studies of food sterilization and electron chemistry, was also developed under his direction.

Charlton was graduated from Grinnell College in 1913; in 1918 he received his Ph.D. in chemistry from the University of Illinois. During 1918 and 1919 he served as a lieutenant in the Chemical Warfare Service, as instructor in chemistry at the University of Illinois, and as a staff member of E. I. du Pont de Nemours. The following year he joined the



staff of the G.E. Research Laboratory.

Although originally trained as a chemist, his initial investigations of the chemical problems of sodium lamps led him into electronics, where he concentrated most of his later efforts. During his long career he has worked on a variety of problems concerning vacuum tubes, including the introduction of getters and the use of alkali metal vapors. He was in charge of the groups responsible for construction of General Electric's 10-Mev, 50-Mev, and 100-Mev electron accelerators, in addition to the 70-Mev synchrotron.

Under his direction, the use of hard glass envelopes for x-ray tubes was introduced and came into general use. Methods of obtaining high-voltage x-rays by means of a multisection tube, as developed by W. D. Coolidge, were applied with Charlton's help. He became a consultant in the nucleonics and radiation section of the electron physics research department in 1954.

Recent Deaths

CHARLES C. GROVE, Baldwin, N.Y.; 80; retired professor of mathematics at City College of the City of New York; 12 Jan.

JOSEPH H. HEDGES, Chevy Chase, Md.; 73; retired mining engineer who served 29 years with the U.S. Bureau of Mines; 12 Jan.

HENRY P. MANNING, Providence, R. I.; 96; professor emeritus of mathematics at Brown University; oldest member of the American Mathematical Society; 11 Jan.

EDWARD J. REARDON, Washington, D.C.; 28; associate editor and head of the Washington bureau of *Chemical and Engineering News*; 10 Jan.

HARRY B. SHAW, Washington, D.C.; 86; former U.S. Department of Agriculture plant pathologist; expert photographer; 12 Jan.

DONALD W. TAYLOR, Worcester, Mass.; 55; associate professor of soil mechanics at Massachusetts Institute of Technology; 24 Dec.

RAY E. TORREY, Amherst, Mass.; 69; professor of botany at the University of Massachusetts; 16 Jan.

SAMUEL WEISHOFF, New York, N.Y.; 66; civil engineer and a partner in Weinberger, Weishoff, Leichtman, and Quinn, New York; 12 Jan.

Education

■ The Franklin Institute, Philadelphia, Pa., and the Remington Rand UNIVAC division of the Sperry Rand Corporation have announced the signing of a contract for the installation of a complete

UNIVAC Computing Center and an integrated computation exhibit in the Franklin Institute. The center will be operated by institute personnel under the supervision of Donald Houghton, chief of the analysis section in the division of electrical engineering of the Franklin Institute Laboratories. Computations will be performed for both the laboratories and the public.

■ A plan to increase the supply of well-trained high-school teachers of science will be initiated next fall at a year-long workshop at Teachers College, Columbia University. It will be especially designed for professors at colleges that prepare science teachers. A criterion for selecting fellowship candidates will be their "ability and willingness to pass on their knowledge."

The workshop will start on 1 Oct. with a group of participants that will represent between 12 and 18 colleges. The program will be financed jointly by industry and by Teachers College. The cost for the first year is \$79,000, of which \$20,000 will be underwritten by the college; the remaining \$59,000 will be contributed by corporations, industry, and foundations. About \$35,000 already has been given or pledged by some 18 organizations.

It is hoped that four additional workshops can be carried out at Columbia, for it is expected that it will take at least 5 years for the program to make itself felt. In that time workshop members will have introduced results of their work in their own institutions and will have begun to train science teachers along the lines developed at the workshop.

■ Effects of radiation on living creatures will be studied in a special course this spring at Duke University. The new one-semester course, which will begin on 1 Feb., will be conducted by the university's zoology department in cooperation with the Oak Ridge National Laboratory.

John S. Kirby-Smith, biophysicist in the biology division at Oak Ridge, will serve as visiting professor at Duke to organize and teach the course. Other Oak Ridge scientists who will be guest lecturers are John Totter, biochemist; Richard Kimball, protozoan geneticist; and Arthur Upton, pathologist.

■ The University of Wisconsin has received a grant of \$249,700 from the National Science Foundation to inaugurate an experimental program designed to train high-school teachers to teach science and mathematics more effectively. The program will begin next fall with 50 high-school science and mathematics teachers, chiefly from Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin. Harvey Sorum of the Univer-

sity of Wisconsin's chemistry faculty will direct the program.

The program will first be tried at the University of Wisconsin and at Oklahoma A. and M. College. If successful, it will be expanded to include eight institutions in the academic year 1957-58, with the idea that advanced teacher training in science would become a continuing program in which science teachers in all parts of the United States could participate.

Each teacher will receive \$3000 with an additional allowance of \$300 for each dependent, plus tuition fees and travel allowances. To be eligible to participate in the program, a teacher must have a bachelor's degree; he must have taught for three or more years; he must be teaching science or mathematics; he must show scholastic and teaching ability; and he must be under 46 years of age. The deadline for submission of applications is 1 Mar.

Grants, Fellowships, and Awards

■ Nominations for the \$1000 Eli Lilly and Company research award for 1956 are invited. The award is made annually to a young microbiologist who has performed outstanding research in bacteriology or its related fields. To be eligible the nominee must be less than 35 years of age on 30 Apr. 1956. Nominations for the award should be addressed to Dr. S. E. Luria, Chairman, Nominating Committee, and sent to John Hays Bailey, Secretary-Treasurer, Society of American Bacteriologists, Sterling-Winthrop Research Institute, Rensselaer, N.Y., to reach that office not later than 10 Feb. Four copies of all material should be submitted and must include the following: month, day, and year of birth; curriculum; list of publications; specific reference to the research upon which the nomination is based; and supporting letters, if possible. No reprints or manuscripts should be submitted.

■ The Williams-Waterman Fund for the Combat of Dietary Diseases has announced that during the fiscal year ended 31 Oct. 1955 grants-in-aid of research in the amount of \$131,573 were made. The objective of the Williams-Waterman Fund is the advancement of scientific knowledge concerning all aspects of human nutrition and metabolism, with preference being given to proposals that may be expected to make an early contribution to the nutritional well-being of humanity.

Since the principal opportunities for direct attack on nutritional deficiencies lie abroad, the fund has continued to support nutrition research in several foreign countries. At the same time,

long-range, fundamental investigations in nutrition and metabolism in the United States have received aid. Requests for information or for grant application forms may be addressed to the Williams-Waterman Fund, Research Corporation, 405 Lexington Ave., New York 17.

■ A number of graduate and advanced research fellowships are offered by the Massachusetts Institute of Technology for study and research in electronics. These are known as industrial fellowships in electronics and are sponsored jointly by a group of industrial organizations concerned with the advancement of electronics and its applications.

The stipend of a graduate student fellowship will be between \$1500 and \$2400 for the academic year, according to experience and qualifications. In addition tuition fees will be paid for the fellow. Advanced research fellowships will be awarded to candidates possessing the Ph.D. degree or its equivalent who, without enrolling as graduate students, wish to pursue advanced research. The stipend will range from \$3000 upward, according to the qualifications of the recipient.

An applicant for an industrial fellowship in electronics should communicate with the Director, Research Laboratory of Electronics. Application should be made at least 4 months prior to the intended date of entrance.

■ The National Society for Crippled Children and Adults has announced that approximately 20 scholarships and fellowships for two separate training programs will be awarded this spring and summer to professional persons who work with crippled children and adults. In one training program, cosponsored by Alpha Gamma Delta and the society, fellowships will be awarded for specialization in counseling the cerebral palsied and other severely handicapped persons.

Training will be held at the Institute of Physical Medicine and Rehabilitation, New York University-Bellevue Medical Center, 18 June-13 July. Fellowships will be awarded to qualified counselors, guidance teachers, employment interviewers, placement personnel, and other professional persons working with the physically handicapped. Individual grants will total approximately \$300 for the course, with \$160 of this amount used for tuition and laboratory fees. The deadline for receipt of applications for these fellowships is 15 Mar.

The second training program is jointly sponsored by Alpha Chi Omega and the National Society. Scholarships are provided to assist professionally trained persons in intensive study that is related to work with children and adults having cerebral palsy. Individual grants for

scholarships vary in amounts up to \$750, depending upon the length and scope of the course chosen. Training is given at various institutions under the guidance of a member of the American Academy of Cerebral Palsy. The deadline for receipt of applications under this program is 1 Apr.

Application forms and other information on both the scholarship and fellowship programs may be secured from the Personnel and Training Service, National Society for Crippled Children and Adults, 11 S. LaSalle St., Chicago 3, Ill.

In the Laboratories

■ The Atomic Energy Commission has announced that a system of competitive bidding will be instituted for leasing uranium deposits developed by the AEC on withdrawn public lands and certain other areas under AEC control. Lands affected include those originally purchased by the Manhattan Engineer District that were subsequently transferred to the AEC and public lands that were withdrawn from mineral entry at the request of the AEC for exploration purposes.

Leases will be awarded to the acceptable bidder offering the highest cash bonus by sealed bid. The royalty rate, work requirements, and other conditions will be stated in the invitation to bid. These conditions will be determined by the AEC and will be based on the estimated size and grade of the deposit and the cost of mining facilities and production.

However, leases will be negotiated rather than offered for competitive bidding when it is determined that special circumstances make negotiation preferable in the best interest of the Government. For example, negotiation might be employed to lease an AEC-controlled deposit that could be economically mined from the underground workings of an adjoining privately owned mine, but could not be economically mined from a separate shaft or entry. Also, extensions of existing leases may be handled by negotiation rather than competitive bidding, particularly where the lessee has developed ore reserves at his own expense.

■ Truesdail Laboratories, Inc., of Los Angeles, research and testing firm, has established an operating division laboratory in Honolulu, and arrangements have been made to lease space in a new building soon to be erected by the Hawaii Chemical Company, Ltd. The new Honolulu division will render applied laboratory services, with certain highly technical problems to be handled by the staff and specialized equipment in the

Los Angeles headquarters. The firm's present Research Advisory Board will be expanded to include specialists from the University of Hawaii.

Miscellaneous

■ One of the most outstanding events in the history of the American Physical Society was the session honoring Enrico Fermi that was held at the 1955 Washington meeting of the society. This consisted of addresses by H. L. Anderson, E. Konopinski, F. Seitz, E. Segrè, and W. H. Zinn, and of the words by which H. A. Bethe as chairman (and organizer of the session) introduced the session as a whole and the speakers severally.

These addresses and Bethe's remarks were recorded on tape by R. E. Wolford and J. B. Wise, whose avocation is the making of records, and who made these gratuitously as a service to the society. Through their courtesy also, reproductions of the records on tape or disk will be made available in any quantity and may be purchased at no more than cost.

The six records, either in the form of tape (7-inch reel, 1/4-inch tape, 1200 or 1800 feet in length) or 12-inch micro-groove LP disk, will be sold separately or all together. The price for the whole set, tape or disk, will be \$30. The price for any disk is \$5; the price for the tapes of Anderson, Bethe, Konopinski, and Seitz is \$5 for each; the price for the (longer) tapes of Segrè and Zinn is \$7.50 each. These figures include postage for orders from the United States, Canada, and Mexico.

Checks or money orders should be made payable to the American Physical Society and mailed to Dr. R. D. Huntoon, National Bureau of Standards, Washington 25, D.C. Anyone who places an order from abroad should ascertain the postage required, deduct 50 cents, and remit the difference with his order. The shipping weight is 1 pound for each disk or tape.

■ Among the articles in the February issue of *The Scientific Monthly* is "Challenge of arid lands" by B. T. Dickson. This article is based on an address given 28 April 1955 at the International Arid Lands meetings, sponsored by the AAAS and its Southwestern and Rocky Mountain Division, at the University of New Mexico, Albuquerque. The other articles include "Early history of radio astronomy," George C. Southward; "Problems in zoological polymorphism," John M. Burns; "Mathematics and natural philosophy," Niels Bohr; and "Techniques used in studies with high-intensity gamma radiation," L. E. Brownell and J. V. Nehemias.

Seventeen books are reviewed.

Reports and Letters

Quantitative Underwater Study of Benthic Communities Inhabiting Kelp Beds off California

By use of a Cousteau-Gagnan Aqualung and a heavy-duty diving suit, the sea bottom off La Jolla, Calif., was explored during the spring of 1955 in an attempt to assess the standing crop of the benthic animals and plants that live in association with the giant kelp, *Macrocystis pyrifera*. This method of investigation insures free movement under water and enables one to make more extensive observations of the submerged communities than one can by dredging or by diving with a helmet (1).

The visibility at the bottom is largely limited by the depth, the density of overlying kelp, the turbulence, and the amount of suspended matter in the water. Thus, on clear days at a depth of 20 m, the visibility ranges between 1 and 10 m.

Cross sections of the sublittoral region, which extends more than 400 m from the low-tide level to the outer edge of the kelp beds, were surveyed. The organisms dwelling on the bottom were analyzed quantitatively by the quadrant method. The quadrants used enclosed an area of $\frac{1}{4}$ m²; for the larger kelp as well as for animals dispersed over wider areas, the number of organisms was counted along lines of 2- or 10-m length in different directions.

The results of this survey reveal a zonal distribution of the chief submerged plants and animals, which seem to be controlled chiefly by light and temperature.

Thus, on the exposed rocks below mean low-water spring tide, a community dominated by the sea grass *Phyllospadix scouleri* flourishes best under surf conditions and extends down to a depth of about

7 m, covering 80 to 100 percent of the rock surface. Epiphytes on *Phyllospadix* consist largely of *Porphyra naiadum* var. *australis*, *Melobesia mediocris*, and *Ectocarpus granulosus*; *Callithamnion californicum* and *Ceramium pacificum* occur as secondary epiphytes. This community is poor in animals, and—apart from *Membranipora*, *Caprella*, hydroids, and a few small snails—the gross weight obtained in the quadrants is owing mainly to the sea grass and amounts to an average value of 3634 g/m².

A *Pterygophora-Eisenia* community flourishes where the sea grass ceases to grow, at first as widely scattered individuals intermingled with *Egregia laevigata*, *Cystoseira osmundacea*, *Codium fragile*, *Dictyota binghami* and *Dictyopteris zonarioides*; it reaches a climax in deeper water between 10 and 20 m, where the two main Laminariales, *Pterygophora* and *Eisenia* form, together with *Laminaria farlowii*, a "forest" under the large *Macrocystis* plants.

Macrocystis pyrifera forms extensive beds ranging in width between 200 and 500 m in a depth of water from 7 to 25 m. Individuals become more crowded in the middle of the beds, with holdfasts 1 to 2 m apart. At the outer edge, *Macrocystis* becomes replaced by scattered individuals of the elk kelp, *Pelagophycus porra*, in a depth of water of 20 to 25 or 30 m.

Where *Macrocystis* grows on outcropping rocks or on boulders, it meets with competition from sea urchins, which clear whole areas of kelp; this is demonstrated by the patchy appearance of the beds at the surface. Survival of kelp plants depends largely on the enormous production of juvenils, which grow on a variety of substrata, including other algae and sea grass.

The standing crop of the *Macrocystis* plants in these beds is estimated to be between 25 and 40 tons/acre, and average annual yield is estimated to be about 4 to 6 tons/acre (fresh wt.). This was judged by observations at the bottom and on the surface, as well as by studies of aerial photographs, by weighing representative samples, and by laboratory experiments on the growth rate of kelp. Under favorable conditions, the latter ranges between 3 and 5 cm per day.

The lowermost stratum of vegetation is occupied by a coralline community that forms an extensive cover under the larger kelps. *Corallina chilensis*, *C. gracilis*, *Bossea orbigniana*, *B. gardneri*, *Lithothrix aspergillus*, and *Lithothamnion* spp. are the chief calcified algae inhabiting this substratum. The quantity and quality of organisms inhabiting this community were found to vary with depth as follows: (i) the percentage of cover by the dominant alga decreases with depth, hence the production per unit area decreases; (ii) *Bossea* preponderates over the *Corallina* beyond a depth of 15 m. These modifications are accompanied by modification in the fauna that live in association with the corallines. For example, the sea fans, red and pink abalones, the sea star *Henricia leviuscula*, together with the holothurian *Stichopus parvirens* and the acorn barnacle *Balanus tintinnabulum*, become noticeable at 20 to 25 m; some of these appear for the first time at such depths. Table 1 gives a comparison of production of the coralline community at different depths.

It has also been found that, while the total weight of plants decreases with depth, that of the animals tends to increase. On the basis of the foregoing survey, an average figure for the standing crop of the organisms that inhabit the rocky bottom of the kelp beds, including *Macrocystis* itself, would approach 9.4 kg/m² of sea bottom, or approximately 38 tons/acre. These figures do not include the pelagic forms.

ANWAR ABDEL ALEEM*

Division of Marine Botany, Scripps Institution of Oceanography and Institute of Marine Resources, La Jolla, California

Notes

1. Contribution from the Scripps Institution of Oceanography, new series, No. 824.

* Permanent address: Oceanography Department, Faculty of Science, Alexandria, Egypt.

28 June 1955

Metabolite of Phenobarbital in Human Urine

A metabolic product of phenobarbital was recently isolated from the urine of a dog that had received daily doses of the drug for three weeks. It was identified as the *p*-hydroxy derivative and was subsequently synthesized by Butler (1). We have found this metabolite in the urine of two human beings who died after barbiturate ingestion. It was possible to determine the concentrations of the free and conjugated forms.

Ultraviolet spectrophotometry was used for initial quantitation (2); this was followed by paper chromatography for the identification of the original drug and for

Table 1. Standing crop (average fresh weight) of the coralline community at different depths below mean sea level.

Depth (m)	Plants (g/m ²)	Animals (g/m ²)	Total wt. (g/m ²)
1.5	4667	125	4792
7	2490	329	2819
15	1972	392	2364
22	606	377.2	983.2

its separation from the metabolite (3).

In case No. 1, death was attributed to acute barbiturate intoxication and positional asphyxia. A half-filled bottle of phenobarbital tablets was found near the body.

The entire sample of urine (390 ml) was buffered at pH 7 and exhaustively extracted with ether. The ether extracts were combined, washed with 0.2N HCl, dried with powdered Na_2SO_4 , and shaken with 0.05N NaOH until all the barbiturate was extracted. The ultraviolet absorbencies were recorded at pH 9.5 and pH 2. The barbiturate was then reextracted with fresh ether from acid solution, the volume was reduced, and the ether solution was applied to 6 sheets of paper for chromatography (3).

For a more controlled preliminary study, two 2-ml samples of the original urine were extracted in parallel by the afore-mentioned procedure. In order to locate and study the zones after chromatography, we used the following procedure: initial scanning of one strip by densitometry (4) pinpointed the R_f values; the strip was eluted section by section with 0.05N NaOH, and the ultraviolet absorption spectra were recorded to determine which of the substances present possessed spectra characteristic of the 5,5-disubstituted barbiturates. At the same time, quantitation was accomplished. The other strip was split vertically in two, and the silver acetate and potassium permanganate tests were applied (3).

Two barbiturates were found. One was located at R_f 0.50 and was presumably phenobarbital. It gave a positive result with the silver acetate reagent and a negative result with potassium permanganate. The other barbiturate was located at R_f 0.29 and gave positive results with both reagents. The results obtained when known and comparable amounts of both phenobarbital and *p*-hydroxyphenobarbital (5) were carried through the same procedure coincided in every respect.

The phenobarbital and its metabolite were removed from the 6 sheets of paper. Each substance was recrystallized from hot water. Mixed melting-point determinations with the known pure compounds proved the presence of phenobarbital and *p*-hydroxyphenobarbital in the urine.

The concentration of the metabolite was calculated from the absorptivity of the *p*-hydroxyphenobarbital. The concentration of phenobarbital was 5.8 mg/100 ml of urine. The concentration of *p*-hydroxyphenobarbital was 11 mg/100 ml.

The 390 ml of urine that had been extracted was then hydrolyzed according to Butler's method (1); after hydrolysis, the procedure was continued as outlined here.

The concentration of *p*-hydroxyphenobarbital was found to be 9.2 mg/100 ml of hydrolyzed urine. The compound was recrystallized and mixed melting-point determinations confirmed the identification.

A barbiturate concentration of 7.2 mg/100 ml of blood was found by ultraviolet spectrophotometry (2). The results of a paper chromatographic study as outlined for urine showed that the only barbiturate detectable in extracts from 25 ml of blood was phenobarbital.

A 30-g sample of homogenized liver was analyzed in the same manner as blood. A barbiturate concentration of 12 mg/100 g of liver was found. The chromatographic study showed that only phenobarbital was present in the liver extracts.

Only 25-ml of fluid stomach contents were available. This sample was analyzed by the same procedure that was used for blood and found to be negative for barbiturate.

In case No. 2, a bottle known to hold 75 1½ grain tablets of phenobarbital was found empty in a coat pocket of the deceased. A study of the urine and blood disclosed results similar to those obtained in case No. 1.

In the first case presented, 46 percent of the *p*-hydroxyphenobarbital was conjugated; in the second, 20 percent was in the conjugated form.

E. J. ALGERI

A. J. McBay

Department of Legal Medicine,
Harvard Medical School,
Boston, Massachusetts

References and Notes

1. T. C. Butler, *Science* 120, 494 (1954).
2. J. T. Walker, R. S. Fisher, J. J. McHugh, *Am. J. Clin. Pathol.* 18, 451 (1948).
3. E. J. Algeri and J. T. Walker, *ibid.* 22, 37 (1952).
4. A. J. McBay and E. J. Algeri, *ibid.* 24, 1139 (1954).
5. We wish to express our appreciation to Thomas C. Butler of the department of pharmacology, University of North Carolina School of Medicine, for his interest and cooperation in supplying us with the reference sample of *p*-hydroxyphenobarbital.

15 August 1955

Body Composition and Energetics in Obesity Induced in Mice by Adrenotropic Tumors

Some of the characteristics of a transplantable pituitary adrenocorticotrophic tumor induced in mice that had been exposed to ionizing radiation have been described (1). The salient changes produced in the recipients are enlargement of the adrenals (and of no other endocrine organ,) leukopenia (notably lymphocytopenia), atrophy of the thymus and the spleen, polyuria rarely with gly-

cosuria and hyperglycemia, obesity, and sensitivity to infection that usually kills the host while the tumor is still small. Some tumor-bearing mice reach weights in the neighborhood of 45 to 50 g as compared with a limit of about 30 g for controls of the same strain (LAF₁). In the course of successive passages, the "overweight" component of obesity became less marked, although obesity (as defined by a very much increased fat content) was still always present. This is particularly evident in the experiments presented here, where the mice, bearing small grafted tumors, had a normal weight but more than twice the normal fat content. In other words, they are "obese"—that is, grossly "overfat"—as determined by body composition.

This report (2) compares the energetics and body compositions of adrenocorticotrophic tumor-bearing mice (ATO) with those of normal controls and of adrenalectomized tumor-bearing animals (Adrex-T) of similar age. It was noted earlier that obesity along with other secondary changes rapidly disappears if the adrenals of the tumor-bearing mice are removed. Therefore, the inclusion of this last type of animal provides a test of the effect of the tumor per se without the overproduction of adrenal hormones.

A total of 47 mice of the LAF₁ strain were used in the study of energetics. Sixteen of these mice had been grafted with tumors 10 weeks previously; at the time of the study, they weighed 27.0 ± 2.4 g. Fourteen animals of the same strain and age were grafted at the same time and immediately adrenalectomized; they weighed 27.4 ± 2.1 g when studied. The 17 control animals weighed 27.0 ± 2.5 g. Spontaneous activity was determined over a 3-week period using rotary (squirrel) cages as previously described (3); the groups were rotated among 16 cages so that each animal spent a total of 7 days under measurement. Food (ground Purina chow) intake was recorded for each animal during that period. Basal oxygen consumptions were determined as previously described (4). Results point to a positive energy balance in the ATO animals: spontaneous activity, expressed in number of revolutions per day, was found to be 6024 ± 3003 for the controls, 4336 ± 1997 for the Adrex-T mice, and 4555 ± 2439 for the ATO mice. The difference is significant ($p < 0.002$) between control and ATO animals, but it is not significant between the two groups of tumor-bearing mice. Food intakes were 4.8 ± 1.0 g/day for the controls, 5.1 ± 0.7 g/day for the Adrex-T mice, and 5.8 ± 0.9 g/day for the ATO mice. The difference between the controls and the ATO mice is highly significant ($p < 0.001$); between the Adrex-T and ATO mice, it is significant ($p < 0.002$). There was no difference in basal oxygen expen-

Table 1. Fatty acids and cholesterol content of extrahepatic and liver in 18 adrenotropic tumor-bearing mice (ATO), 13 adrenalectomized tumor-bearing mice (Adrex-T), and 22 controls.

Type	Mice	Carcass lipid content				Liver lipid content			
		Fatty acids		Cholesterol (mg)	Wt. (g)	Fatty acids		Cholesterol (mg)	Wt. (g)
		Wt. (g)	(%)			Wt. (mg)	(%)		
Controls	27.1±2.9	2.10±0.63	7.78±2.48	54.8± 9.71	1.54±0.04	0.049±0.019	3.80±1.43	4.88±0.94	
Adrex-T	27.8±2.86	1.77±0.49	6.21±1.27	52.9±12.40	1.56±0.15	0.063±0.026	4.04±1.18	4.73±1.18	
ATO	26.8±2.32	4.25±1.12	17.30±5.16	70.2±10.79	1.82±0.25	0.107±0.069	6.13±2.66	6.72±1.58	

diture among the three groups. The ATO mice under study did not show glucosuria, although they showed some polyuria. The fact that weight remained stationary in the ATO mice despite the manifestly positive energy balance can be interpreted when body composition (Table 1) is considered.

Body composition was determined on a total of 54 animals: 18 ATO mice, 14 Adrex-T mice, and 22 controls. The tumors were small—2 to 5 mm in diameter. Cholesterol and fatty acids were determined by standard methods. The cholesterol digitonide precipitation results were checked by Sperry-Webb (5) determination on the acetone-ethanol extract. Results in Table 1 show that the ATO mice, despite their normal weight, were effectively obese because they contained twice as much extrahepatic fat as controls and 3 times as much as the Adrex-T animals. Liver fat is similarly elevated as are both carcass and liver cholesterol. All differences concerning carcass fat and cholesterol are highly significant, with Student's *t* values between 5 and 10. Differences in liver fat are significant ($p < 0.001$ between ATO and controls, $p < 0.01$ between ATO and Adrex-T). The difference in liver cholesterol between ATO and controls is significant ($p < 0.01$).

In previous studies (reviewed by Mayer, 6), a distinction has been established between "metabolic" and "regulatory" obesities. In metabolic obesity, which is exemplified in mice by the obese-hyperglycemic syndrome, lipogenesis from acetate is increased over the control values even when both obese and control animals are submitted to restricted feeding or fasting. Reduction in weight to the normal figure does not restore normal body composition. Such characteristics are not seen in regulatory obesity, which is exemplified in mice by goldthioglucose and hypothalamic obesties. The ATO animals obviously fulfill one of the criteria of metabolic obesity: considerably elevated fat content even when the body weight is normal. The considerably increased body cholesterol content, which is also seen in the obese hyperglycemic syndrome but not in regulatory forms of obesity, is also suggestive. Studies of C^{14} -carboxy-labeled acetate incorporation show very significantly in-

creased lipogenesis and cholesterologenesis in fasting, as well as nonfasting, conditions and confirm the metabolic nature of this new type of obesity (7).

Mice bearing adrenotropic tumors provide an additional illustration of the difference between *overweight* and *obesity*. They appear to constitute an interesting example of metabolic obesity. Finally, they are a useful tool in the study of the mode of action of corticosteroids.

JEAN MAYER
CLAIRE ZOMZELY
J. FURTH

Department of Nutrition,
Harvard School of Public Health, and
Childrens Cancer Research Foundation,
Boston, Massachusetts

References and Notes

1. J. Furth, E. L. Gadsden, A. C. Upton, *Proc. Soc. Exptl. Biol. Med.* **84**, 253 (1953).
2. This work was supported in part by grants No. A-49 and C-2259 from the National Institutes of Health and by the Sugar Research Foundation, the Kellogg Company, and the Nutrition Foundation, Inc. We gratefully acknowledge the excellent assistance of Ann J. Stoops and Evelyn Gadsden.
3. J. Mayer, *Science* **117**, 504 (1953).
4. J. Mayer et al., *Endocrinology* **50**, 318 (1952).
5. W. M. Sperry and M. Webb, *J. Biol. Chem.* **187**, 97 (1950).
6. J. Mayer, *Voeeding* **16**, 62 (1955); *Nutrition Abstr. and Revs.*, in press.
7. A report of these studies is in preparation.

22 August 1955

Summer Jobs for High-School Students

What is the attitude of high-school students toward careers in science? In a recent survey, Melvin Barnes, assistant superintendent of the Oklahoma City public schools, asked 100 high-school juniors why more students did not take courses in science and mathematics. Although I am only a junior in high school, I would like to give a brief account of this survey and then offer my own idea on how to improve the attitude of students.

One of the startling answers to Barnes' questions was "Einstein! Long hair and a sweat shirt." Other students answered by describing scientists as "squares" or "little old men with beards working in musty laboratories." The majority pictured mathematics and science courses as being

dull. Also, some students stated that higher education in any scientific field was expensive, while the job opportunities after graduation were poor. Barnes concluded from his survey that there was a need for better vocational counseling and hinted that better teaching methods might make science subjects seem less difficult.

Since I am not a member of the teaching profession, I am unable to comment on Barnes' conclusions. However, I would like to offer a suggestion of my own. My idea is to place the task of encouraging students to choose a scientific career in the hands of all members of the scientific field. In many high schools there are programs by means of which students are permitted to gain "on the job" experience in the commercial fields. Why are not summer jobs offered to interested high-school students as laboratory aides or the like? Such students are just as capable of carrying out laboratory procedures as clerking in a store or stocking shelves. The point that I am trying to bring out is that one summer of actual work in the field of science is a greater encouragement to decide upon a scientific career than a year of constant lecturing on the subject by a teacher. This sort of program also inspires the student to apply for scholarships if he cannot afford higher education. It is certainly beneficial to the student in the way of experience that will be useful to him in college.

JAMES G. BUSSE
Cotter High School, Winona, Minnesota
12 January 1956

Magnetic Techniques for in vitro Isolation of Leucocytes

Over a period of time, this laboratory has undertaken studies on various techniques for the isolation, *in vitro*, of leucocytes in blood. Since relatively little has been published concerning the applicability of certain techniques investigated here, a brief preliminary note is presented to summarize our experience with these methods.

The usual approach to the isolation of white cells from human blood has been to increase the sedimentation rate of the erythrocytes by means of the fibrinogen technique (1). However, it has been found that this technique suffers from several shortcomings. First among these was the observation that the white cell fraction so obtained is appreciably contaminated with 30 to 60 percent erythrocytes. Moreover, it was found that the bovine fibrinogen technique is limited in its applicability because it does not produce any observable effect on the sedimentation rate of freshly collected and citrated bovine blood or sheep blood.

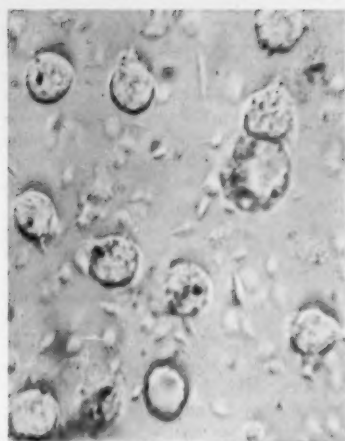


Fig. 1. Microphotograph showing leucocytes with phagocytized iron that appears as dark spots within the leucocytes. Starch particles are visible in the background.

In an attempt to develop a more efficient and generally applicable technique, a series of studies was undertaken in an effort to utilize certain characteristic properties of the several classes of cells that are found in blood. Experiments were performed in an attempt to utilize the paramagnetic properties of hemoglobin as a method of selectively removing erythrocytes. Since the ferrous iron in the porphyrin ring of hemoglobin has four uncoupled electrons in the third orbitals (2, 3) these should contribute a magnetic moment μ , given by

$$\mu = \sqrt{n(n+2)} = 4.90 \text{ Bohr magnetons,}$$

where n is the number of uncoupled electrons. This paramagnetism is lost, however, when the ferrous iron complexes with certain molecules such as oxygen, cyanide, and others (4). Under these circumstances, the uncoupled electrons form hybridized orbitals of the d_{sp_3} and related types. Although the paramagnetic properties of hemoglobin should result in a relatively weak attraction of the erythrocytes into a magnetic field, it was felt that the approach warranted at least some preliminary study.

Venous blood was drawn directly from patients and passed through an ion-exchange column of Amberlite 112 in the sodium form. In this manner, calcium was removed without the addition of complexing agents, which could conceivably interfere with the paramagnetic properties of the ferrous iron. The blood was then collected in a 12-inch, 5-mm-bore glass tube, deoxygenated under vacuum, and finally sealed under a nitrogen atmosphere. The blood was then subjected to a highly inhomogeneous field of about 20,000-gauss maximum intensity at the center (5). The sedimentation of

the blood so treated was compared with that of similar samples that had not been subjected to the magnetic field. Despite the known paramagnetic properties of hemoglobin, no readily observable difference in the two sedimentation rates was apparent. This failure is, however, not surprising since, as previously mentioned, it can be shown that the potential energy effect for the paramagnetic ion is quite small; in addition, there is the counterbalancing action of the diamagnetic cell constituents and blood proteins.

Because of the difficulties inherent in these techniques, it was decided to attempt isolation of the cells by employing the phagocytic properties of certain of the leucocytes *in vitro*. A similar approach *in vivo* has been reported by Rous and Beard (6) and others (7). In the studies reported here, an attempt was made to induce *in vitro* phagocytosis of iron granules. Phagocytosis of iron granules in the experiments was ascertained by observing the response of the phagocytes to an applied magnetic field. When ingestion of an iron particle had occurred, the ingested particle appeared as a dark spot (1 to 3 μ in diameter) within the leucocyte, and the cell underwent a distinct movement when a magnetic probe was brought in proximity to the microscope slide. The experiments were conducted in plastic- or silicon-lined glass test tubes in an incubator that was maintained at 37°C. Gentle stirring was provided by a special rotary rack that revolved the test tubes about the long axis at a slow rate of speed. Initial experiments in which iron powder (8) was added directly to citrated human blood resulted in little if any uptake over a period of 2 hours. Microscopic observation revealed that the direct addition of iron to the blood samples resulted in the formation of large clumps of iron that were unable to undergo phagocytosis because of their large size.

In an attempt to produce a more stable iron suspension and in order to increase the phagocytotic propensities of the leucocytes, a special iron-starch preparation was finally developed that gave satisfactory results. This preparation was made by dissolving 10 g of solubilized starch in 200 ml of isotonic sodium chloride, then adding 20 g of powdered iron. The suspension was then brought to 80°C for 30 minutes and was finally filtered through a layer of gauze in order to remove some of the larger aggregates. The iron particles in the preparation so obtained showed little tendency to settle out even after the preparation had been left standing for several hours. Microscopic observations indicated that the iron particles had become coated with starch. Attempts were made from time to time to grind the iron particles in order to increase the 1-to-3- μ portion. However, it was found that grinding the powder in

a number of devices such as an automatic agate mortar, ball mill, and in recently designed colloidal mills (9) did not materially affect the size distribution of the powdered iron.

When the preparation was used, appreciable phagocytosis occurred. A typical experiment was conducted by adding 5 ml of the iron starch preparation to 20 ml of freshly drawn and heparinized or citrated blood in a plastic test tube. The sample was incubated at 37°C while it was undergoing slow rotation. Samples of the blood were examined at half-hour intervals over a period of 2 hours. Under the conditions described, appreciable phagocytosis occurred as is shown in Fig. 1. The iron is visible as small dark spots within the phagocytes. A number of starch granules are visible in the photograph. In a number of instances, it could be shown, by rotating the cells with a magnetic probe, that the iron was not completely phagocytized but rather remained adhering to the cell membrane. Extension of these experiments to white cell preparations that were obtained by means of the fibrinogen technique showed that such cells also phagocytized iron under the conditions described. Indeed, in several instances the fibrinogen-treated cells showed greater iron phagocytosis than cells not so treated.

This *in vitro* phagocytosis of iron provides a convenient method for the magnetic isolation of phagocytes. A number of promising arrangements are now under investigation in this laboratory. One such consists of transferring the incubated blood samples to a paraffin-coated petri dish mounted over an electromagnet. With the field on, the phagocytes are firmly held to the bottom of the dish while the blood protein and erythrocytes can be removed by gently flushing the system with isotonic saline. When the flushing operation has been completed, the magnetic field is cut and the phagocytes are collected by flushing with the saline.

SUMNER LEVINE

East Orange Veterans Hospital,
East Orange, New Jersey

References and Notes

1. R. Baer, F. Serri, P. Kirman, *J. Invest. Dermatol.* 19, 217 (1952).
2. L. Pauling and C. D. Coryell, *Proc. Natl. Acad. Sci. U.S.A.* 22, 195 (1936).
3. R. Pauling, W. B. Whitney, W. A. Felsing, *J. Am. Chem. Soc.* 59, 633 (1937).
4. R. Pauling and C. D. Coryell, *Proc. Natl. Acad. Sci. U.S.A.* 22, 210 (1936).
5. I am indebted to the Metallurgical Laboratory of Bell Telephone Laboratories, Summit, N.J., for making available the electromagnet that was used in these studies.
6. P. Rous and J. W. Beard, *J. Exptl. Med.* 59, 577 (1934).
7. S. St. George, M. Friedman, S. O. Byers, *Science* 120, 463 (1954).
8. Fisher Scientific, hydrogen-reduced.
9. I wish to thank the Admiral Tool and Dye Company of New York for supplying a colloidal mill.

22 August 1955

Book Reviews

Quantum Mechanics. International Series in Pure and Applied Physics. Leonard I. Schiff. McGraw-Hill, New York-London, ed. 2, 1955. xii + 417 pp. Illus. \$6.50.

The revision of this standard textbook and reference work has been accomplished mainly by the addition of topics that either provide further illustrations of general principles or introduce new methods that have been developed since the publication of the first edition in 1949. Among the more important of these are a discussion of a diffraction experiment in connection with the interpretation of the uncertainty principle, an introduction to the use of variational principles in the theory of scattering, and a brief but very clear exposition (following Bethe) of the "effective range" approximation in the treatment of the two-nucleon system. The sections dealing with fundamental particles have been brought up to date by the insertion of brief references to the properties of mesons; a number of references to recent research papers have been added.

It is my opinion that the book's usefulness as a text might have been enhanced further by amplification of some of the sections dealing with fundamental concepts and methods. This is especially the case in the chapter on the matrix formulation of quantum mechanics. The student who has not had an introduction to matrix algebra is likely to feel that the subject is inadequately treated. The discussion of unitary transformations would have been improved, for example, by addition of a short section on the concept of change of basis in a vector space, and the important theorem on simultaneous diagonalization of commuting matrices might well have received further attention. The treatment of angular momentum has been improved by addition of a section on the definition in terms of infinitesimal rotations, but little further use is made of this important concept in the sequel. The section on addition of angular momenta is a description of the general procedure; it would have been improved if an example had been added. Additions of this kind might have been compensated for by abbreviating other detailed mathematical parts of the book

that illustrate relatively less important points. The discussion of representations of the hydrogen wave functions in parabolic coordinates and of the classical theory of the Cerenkov effect are examples.

The book is remarkably accurate, both in detail and in exposition of general principles. It continues, in the second edition, to be an excellent text for courses in quantum mechanics at the graduate level.

J. L. POWELL

University of Oregon

Cardiovascular Renal Problems. Hans Popper and Daniel S. Kushner, Eds. Blakiston Div., McGraw-Hill, New York, 1954. xviii + 325 pp. Illus. \$5.

This is the first volume of a projected series of reproductions of clinical-pathologic conferences held at Cook County Hospital from 1946 to 1953, and it deals with selected problems in the field of cardiovascular-renal medicine from the standpoint of clinical-pathologic correlation. The editors have attempted to "select the clinical problems which are representative of the majority of patients with cardiovascular renal disease encountered in the wards..." and present them in the form of transactions of the hospital conferences.

The introduction is a short informative history of the development of clinical-pathologic correlation, from the first coordinated attempts by Benvenuti and Morgagni to relate the findings at the autopsy table to clinical observations, through Cabot's introduction of clinical-pathologic conferences as an adjunct to medical education, to the present-day philosophy and practice of this teaching exercise.

Under three main headings entitled "Cardiac problems," "Vascular problems," and "Renal problems," 26 conferences are reproduced, covering such specific problems as "Chronic pulmonary insufficiency in sandblaster," "Complication of coronary artery disease," "Deforming arthritis and edema," and "Differential diagnosis of uremia." Each conference has a brief clinical history followed by the usual sections of clinical discussion,

pathologic observations, pathologic discussion, and final pathologic diagnosis. Pertinent references to published work related to the particular problem conclude each conference. In a number of instances, additional, more didactic discussion is included under the heading of "Editors' notes."

The pathologic discussions are uniformly thorough and instructive in contrast to rather sketchy clinical discussions in some sections. There is an abundance of illustrations of pathologic material, both gross and microscopic. However, for a book purporting to stress the correlation between ante- and post-mortem findings there is a surprising dearth of illustrations of clinical material. For example, only three x-rays and no electrocardiograms are reproduced in the entire book.

The purpose of a book such as this is not entirely clear. A clinical-pathologic conference is an important part of medical training, both for medical students and graduates. However, a C.P.C. is inherently a "live performance" where questions, comments, and even arguments can add to the interest. Although the editors state in the preface, "It has been our intention to maintain the spirit of each original conference," in my opinion much of the spirit of a C.P.C. is lost in print, and we are left with a "post-mortem." For the busy physician, this book may warrant an evening's reading but probably is not worth inclusion in his permanent library.

NEIL C. MORAN

*Laboratory of Chemical Pharmacology,
National Institutes of Health*

Principles of Meteorological Analysis. Walter J. Saucier. Univ. of Chicago Press, Chicago, 1955. xvi + 438 pp. Illus. \$10.

This book represents an attempt to narrow the gap between the theoretical material that is covered in basic courses of meteorology and the applied material that is covered in weather analysis courses. Integration of these two broad phases of training stems from the author's connection with the Chicago school of meteorology and the underlying educational philosophies that were developed by Carl-Gustaf Rossby and continued under the direction of Horace R. Byers.

Beginning with an introductory chapter defining atmospheric variables, the book describes the various meteorological charts and diagrams in Chapter 2. An interesting and valuable feature is the discussion of map projections, map scales, measurement of geodetic distances and directions from a map, and great-circle arcs. Ensuing chapters cover hydro-

statics and static stability, scalar and graphical analysis, cross-section analysis, isobaric analysis, and a short treatment of isentropic analysis. The chapter "Analysis of the surface chart" appears to be rather brief but, as pointed out by the author, most of the concepts of surface analysis have been covered in earlier sections. The chapter is devoted to pressure patterns, pressure tendencies, and fronts and associated weather. Chapter 10 presents kinematic analysis in a comprehensive manner, covering streamlines, air trajectories, and the properties of motion of a wind field. The book concludes with short chapters on analysis of large-scale weather patterns in middle and high latitudes, of local weather, and of tropical weather.

The book is well illustrated, although a few of the maps suffer from too great a reduction in size. An appendix contains several useful tables and charts. Reading references in standard meteorological works, which are listed at the end of each chapter, are supplemented by extensive footnote references to the literature. The double-column format permits a large manuscript to be published in a compact volume without reduction of readability.

Saucier has successfully combined into one volume both meteorological fundamentals and practical aspects of synoptic weather analysis. This book should prove useful as a textbook for students of meteorology, whereas those who seek a ready reference on how to draw a weather map would do well to look elsewhere.

DAVID K. TODD

College of Engineering,
University of California, Berkeley

Solar Energy Research. Farrington Daniels and John A. Duffie, Eds. Univ. of Wisconsin Press, Madison, 1955. xv + 290 pp. Illus. + plates. \$4.

This book, the first in the United States, may also be a milestone in accelerated efforts to utilize solar energy. It is not an organized textbook but a compendium of articles presented at a symposium on solar energy in Madison, Wisconsin, in September 1953. About 30 scientists participated, exchanging informal talks about the possibilities of using solar energy. Their papers cover most of the possible fields including: expected world energy demands, the nature and availability of solar energy, space heating and domestic uses of solar energy, solar power, solar evaporation and distillation, atmospheric phenomena, conversion of solar to electric energy, solar furnaces, photosynthetic utilization of solar energy, photochemical utilization of solar energy, a British viewpoint, miscellaneous appli-

cations of solar energy, and suggestions for further research.

The presentation is not homogeneous. Some of the articles are merely short abstracts. Others are highly technical. A few are interesting reading for the layman. There is a general trend that is shared by most authors; they all stress the need for further research and for funds that will make research possible. Relatively few articles express pessimism about the technical or economical limitations of the use of solar energy.

The book is a "must" reader for all those who are attracted to the pioneering prospect of capturing the sun's energy. There is ample reference to the scattered literature of the subject and a list of patents that have been issued in the United States. The book is a storehouse of ideas that may be developed through research, which it will doubtless stimulate.

MARIA TELKES

College of Engineering,
New York University

Determination of Organic Structures by Physical Methods. E. A. Braude and F. C. Nachod, Eds. Academic Press, New York, 1955. xiii + 810 pp. Illus. \$15.

The ever-increasing use of physical methods for the determination of the molecular structures of organic substances has greatly altered the character of organic chemical research during the past two decades. The present book is intended to be an authoritative and comprehensible survey of the various physical methods of structural analysis, each given in sufficient theoretical and practical detail to acquaint a nonspecialist with its scope and limitations. Seven of the book's 22 authors are British, one is Swedish, and the remainder are American. The 16 chapters comprising the book are grouped into three parts: part I is concerned with the determination of molecular size, part II with molecular pattern, and part III with molecular fine structure.

In Chapter 1, entitled "Phase properties of small molecules," H. F. Herbrandson and F. C. Nachod discuss various correlations of melting point, boiling point, molar volume, and parachor with molecular size and structure. Their discussion of mixed melting points is especially good. Chapter 2 by P. Johnson deals with the determination of molecular weights, dimensions and shapes of macromolecules by techniques involving the measurement of osmotic pressure, sedimentation equilibrium and velocity, diffusion rate, and viscosity. The omis-

sion of the more recently developed light-scattering technique from this otherwise excellent chapter is to be regretted.

Part II begins with a chapter by W. Klyne on the use of optical rotation in the determination of molecular configuration. The present treatment of this topic is considerably more detailed than another given by the same author in collaboration with J. A. Mills that has very recently appeared elsewhere [*Progress in Stereochemistry*, vol. 1, W. Klyne, Ed. (Academic Press, New York, 1954)], pp. 204-215], although a good deal of repetition is inevitable. Chapter 4 by Braude deals with absorption spectroscopy in the ultraviolet and visible regions. I question the value (and validity) of the grossly oversimplified explanations of electronic transitions with valence bond notation. (For example, the B_{2u} excitation of benzene is explained as a transition between Kekulé structures.)

In Chapter 5, R. C. Gore discusses the instrumentation, theory, and application of infrared spectroscopy to micromolecular substances. A special section of this chapter by E. S. Waight is concerned with the infrared spectroscopy of macromolecular substances. The chapter is distinguished by the emphasis that it places on the uses of polarized radiation. There has existed for some time a need for a substantial yet comprehensible exposition of the theory and uses of Raman spectroscopy and magnetic susceptibility. Chapter 6 by F. F. Cleveland and Chapter 7 by C. A. Hutchison, Jr., are devoted to these topics, but in my opinion they do not fulfill the need. Admittedly, the subjects are highly complex, but skillful writers with due regard for the limitations of their readers should do more than leave one with an impression of the complexities of their subjects.

Part III is introduced with a chapter by E. Stenhagen on the use of surface films in the elucidation of molecular structures. This is followed by a chapter written by L. E. Sutton on the theory and application of dipole moment measurements. Sutton is to be commended for the freshness and clarity he brings to the subject. Chapter 10 by J. Karle and I. L. Karle deals with electron diffraction, while Chapter 11 by J. M. Robertson deals with x-ray diffraction. Both of these chapters achieve their objectives. In the ensuing chapter, E. B. Wilson, Jr., and D. R. Lide, Jr., present a very welcome discussion of the newest spectroscopy—microwave spectroscopy. Then follows a chapter by J. G. Aston on thermodynamic properties and their use in the investigation of molecular structure. Aston has taken serious liberties with the term *isomer* and uses it interchangeably with the term *conformation* or, as he sometimes prefers, *conformer*!

Chapter 14 by H. C. Brown, D. H. McDaniel, and O. Häfner constitutes, in my opinion, one of the book's highlights. The chapter contains perhaps the most complete compilation of acid and base dissociation constants in the literature, and the writers skillfully employ these data in their presentation of contemporary stereoelectronic theories. The major defect of the chapter is its slighting of entropy effects, which are only briefly mentioned. The use of reaction kinetics in structural problems is discussed by Braude and L. M. Jackman in Chapter 15. I believe it would have been improved by a more thorough examination of the problem of molecularity and kinetic order of reaction.

The final chapter is by C. A. Coulson and deserves special praise for its conciseness and clarity. Its subject is the application of wave mechanics to structural problems: specifically it treats the topics of aromaticity and bond order in a descriptive way from the viewpoints of both the valence bond and the molecular orbital methods of approximation. The ideas put forward here should stimulate research in a number of new directions.

With few exceptions, the book succeeds admirably in its objectives. A compilation of this sort always presents serious problems from an editorial point of view, and in general they have been adequately solved by the editors. It would have been better, however, to have chosen either the symbol F or G for the free energy function rather than to use both symbols for the same function in different chapters of the book (pp. 257, 667). With two exceptions (p. 206, last paragraph; p. 224, line 4), the proof has been carefully read. Only one typographic error has come to my attention (naphthalene in Fig. 4.5).

ALFRED H. FRYE
Chemistry and Abrasives Research
Department, Cincinnati Milling
Machine Company

Magnetic Materials in the Electrical Industry. P. R. Bardell. Philosophical Library, New York, 1955. xiv + 288 pp. Illus. + plates. \$10.

This book is an introduction to the design of apparatus that depends primarily on the magnetic properties of materials. The presentation naturally calls for a careful description of the magnetic materials available, and the first half of the book is devoted to this subject, including a chapter on the theory of magnetic behavior.

As far as I am aware, this is the only book that gives materials and design equal amounts of space in exposition, and

for this reason it is an important forward step in bringing together two essentially related subjects. It thus appears to be well adapted for use as an introductory textbook. As is indicated by the size of the book, the amount of material is limited, and other publications should be consulted for information regarding both materials and design. A larger bibliography would have been useful for this purpose.

The applications that are discussed include power transformers and chokes, direct-current machines, relays, communication transformers and cores, magnetic recording, magnetic amplifiers, electromagnetic and magnetostrictive transducers, and a number of instruments, including magnetrons, that depend on the use of permanent magnets. The uses of magnetic materials in the relatively new fields of the storage of information and of microwave transmission are not covered.

The centimeter-gram-second system of units is used throughout. It is difficult to see how this kind of book could approach its present usefulness if the millimeter-kilogram-second system had been used.

Although the book is written primarily for English students, it is equally well adapted to Americans. The style is simple and clear. References to articles and books for further reading could well have been enlarged, and a longer index would have been more useful. The number of illustrations, about 1.7 per page, is more than average and is a welcome aid in presentation. The price of \$10 seems rather high for a book of under 300 pages.

R. M. BOZORTH
Bell Telephone Laboratories

Books Reviewed in The Scientific Monthly, February

Augustine to Galileo, A. C. Crombie (Harvard Univ. Press). Reviewed by M. Brodbeck.

Science in Our Lives, R. Calder (Michigan State College Press; New American Library). Reviewed by P. Le Corbeiller.

Early American Science, Whitfield J. Bell, Jr. (Inst. of Early American History and Culture, Williamsburg, Va.). Reviewed by J. Oppenheimer.

Ethical Judgment, A. Edel (Free Press). Reviewed by S. C. Pepper.

Current Trends in Psychology and the Behavioral Sciences, J. T. Wilson, C. S. Ford, B. F. Skinner, G. Bergmann, F. A. Beach, F. Pribram (Univ. of Pittsburgh Press). Reviewed by R. W. Gerard.

Politics and Science, W. Easlinger (Philosophical Library). Reviewed by B. Glass.

Charles Darwin: a Great Life in Brief, R. Moore (Knopf). Reviewed by B. Glass.

How to Know the Fresh-Water Algae,

G. W. Prescott; H. E. Jaques, Ed. (Brown, Dubuque, Iowa). Reviewed by W. R. Taylor.

Careers and Opportunities in Science, P. Pollack (Dutton). Reviewed by H. A. Meyerhoff.

Bird Navigation, G. V. T. Matthews (Cambridge Univ. Press). Reviewed by J. G. Pratt.

Psychoanalysis and the Education of the Child, G. H. J. Pearson (Norton). Reviewed by P. S. Sears.

Introduction to Theoretical Organic Chemistry, P. H. Hermans (Elsevier). Reviewed by C. Walling.

Culture and Human Fertility, F. Lorimer (UNESCO, Paris; distr. by Columbia Univ. Press, New York). Reviewed by I. B. Taeuber.

The Story of Medicine, K. Walker (Oxford Univ. Press). Reviewed by I. Galdston.

Highway to the North, F. Illingworth (Philosophical Library). Reviewed by F. Rainey.

Poisons. IV. Téléostéens Acanthoptérygiens, M. Poll (Institut Royal des Sciences Naturelles de Belgique). Reviewed by J. W. Hedgpeth.

Africa Today, G. G. Hames, Ed. (Johns Hopkins Press). Reviewed by H. T. Straw.

New Books

Men, Rockets and Space Rats. Lloyd Mallan. Messner, New York, 1955. 335 pp. \$5.95.

Travels and Traditions of Waterfowl. H. Albert Hochbaum. Univ. of Minnesota Press, Minneapolis, 1955. 301 pp. \$5.

You and the Atom. Gerald Wendt. Whiteside; Morrow, New York, 1956. 96 pp. \$1.95.

Alloy Series in Physical Metallurgy. Morton C. Smith. Harper, New York, 1956. 338 pp.

Science in Action, vol. 1, *TV Library*. Benjamin Draper, Ed. California Acad. of Sciences, San Francisco, and Merlin Press, New York, 1956. 157 pp. \$3.50.

Chemical Engineering, vol. 2, *Unit Operations*. J. M. Coulson and J. F. Richardson. McGraw-Hill, New York; Pergamon, London, 1955. 975 pp. \$9.

Fundamentals of Electroacoustics. F. A. Fischer. Trans. by Stanley Ehrlich and Fritz Pordes. Interscience, New York-London, 1955. 186 pp. \$6.

Yoga Dictionary. Ernest Wood. Philosophical Library, New York, 1956. 178 pp. \$3.75.

Combustion Processes, vol. II, *High Speed Aerodynamics and Jet Propulsion*. B. Lewis, R. N. Pease, and H. S. Taylor, Eds. Princeton Univ. Press, Princeton, N.J., 1956. 662 pp. \$12.50.

Quantitative Bacterial Physiology Laboratory Experiments. Michael J. Pelczar, Jr., P. Arne Hansen, and Walter A. Koznetzka. Burgess, Minneapolis 13, 1955. 150 pp. \$2.75.

Proceedings of the International Conference on the Peaceful Uses of Atomic Energy. Held in Geneva, 8-20 August 1955, vol. 3, *Power Reactors*. United Nations, New York, 1955. 389 pp. \$7.50.

Scientific Meetings

Low-Temperature Physics

A conference on low-temperature physics sponsored by the Institut International du Froid and by L'Union Internationale de Physique pure et appliquée was held in Paris from 2 to 8 Sept. 1955. The meeting was held at the Sorbonne University, so that it would be closely associated with the 9th International Congress of Refrigeration, which took place at the Sorbonne at the same time.

The general committee for the conference included Francis Simon, C. J. Gorter, F. G. Brickwedde, K. Clusius, C. T. Lane, and L. Weil. L. Weil of the University of Grenoble presided over the organizing committee, which made arrangements not only for the scientific meetings but also for many notable social occasions. Approximately 250 delegates from about 15 different countries attended the conference; nearly 50 of them were from the United States. Listed on the program were 160 papers divided among the ten official sessions of the conference. Although this allowed little time for each paper, the presentations were helped considerably by publication and distribution of detailed abstracts of all papers immediately prior to the opening session.

It would not be possible in a short review even to mention all of the many significant scientific contributions in the field of low-temperature physics made at this conference. Consequently, I shall point out only a few papers that interested me personally. (The proceedings of the conference will be published shortly and will contain detailed abstracts of all the papers, together with reports of the discussions.)

In the area of experimental work on superconductivity, interesting new work was presented in papers by Corak, Goodman, Satterthwaite, and Wexler, by Goodman, and by Schawlow. The first two of these papers were concerned with measurement of the electronic specific heats of vanadium and aluminum, respectively. By accurate measurements over a wide range of reduced temperature ($5 > T_c/T > 1$) it was observed that the electronic specific heat in the superconducting state, C_{es} , could be described by an exponential function. This is different from the analytic descriptions for C_{es} adopted to date and is of signifi-

cance for theoretical descriptions of superconductivity, because it strongly suggests the existence of an energy gap in the single-electron energy level spectrum. The need for such an energy gap in the theoretical description of superconductivity has previously been stressed by many authors, in particular, recently, by Froehlich and Bardeen.

The third paper described results of observation of the structure of the intermediate state in superconductors by use of a magnetic powder technique. Diamagnetic superconducting niobium powder was spread over the surface of disks or plates of the samples to be investigated. When a sample was brought into the intermediate state by the application of a magnetic field, the powder remained on the superconducting regions but was forced out of the normal regions through which magnetic flux passed. The powder patterns were then observed photographically. From the observed domain spacings, the surface energy at the supernormal boundary can be derived, thus providing a powerful technique for obtaining this theoretically significant parameter. Tin, indium, lead, and vanadium were studied, and it was found that the surface energy for vanadium was some 1000 times larger than for the first three elements cited.

Among the many papers on liquid helium, two of interest concerning the entropy of superfluid helium were presented by Brewer, Edwards, and Mendelssohn and by Bots. The first paper described new measurements of the heat of transport of superfluid helium II flowing through narrow channels, and the second described measurements of the fountain pressure in helium II to temperatures down to 0.2°K. From both it could be deduced that helium in superfluid flow does *not* carry the phonon entropy with it, a valuable confirmation of the conclusions previously arrived at more indirectly from velocity of second sound measurements. Unfortunately, the accuracy of existing calorimetric data on the entropy of the bulk liquid is insufficient to allow the deduction from these measurements that the entropy of the superfluid is precisely zero.

Three interesting papers, also on liquid helium II, were given by Vinen and Hall. The first reported measurements of the

attenuation of second sound propagated laterally across a rectangular helium-filled tube carrying a longitudinal heat current. The attenuation was found to be proportional to the square of the heat current density, and by observing the time delays in establishing steady values of attenuation after switching the heat current on or off, it was concluded that above a critical velocity the flow of superfluid was turbulent.

The second paper, giving some detail of measurement of rotational frictional forces in helium II, also concluded that rotations of the superfluid result in the appearance of friction of a turbulent character. A similar conclusion that turbulence occurs in superfluid flow at sufficiently high velocities was also noted by Benson and Hallett in their paper describing their work on torsional oscillations of a sphere in helium II.

An elegant test of these conclusions was made by Vinen and Hall. They made second sound velocity and attenuation measurements in a second sound resonator. The resonator, together with its heater and thermometer, was placed in a can of liquid helium, and the *whole assembly* was rotated. On rotation, attenuation that was accurately proportional to the angular velocity was produced. It was concluded, therefore, that the frictional forces within the superfluid responsible for this attenuation are a general property of rotational states of the liquid. By extensions of these and similar experiments, much valuable and new information will be gained concerning the excitations in liquid helium II.

The low-temperature properties of pure liquid He³ were the subject of much discussion. Extensions of measurements to temperatures as low as 0.23°K were reported by Osborne, Abraham, and Weinstein on the specific heat and by Fairbank, Ard, and Walters on the magnetic susceptibility. This work further supported the conclusions previously reached, not only by these authors, but also by Daunt and Heer, by deVries and Daunt, and by Roberts and Sydoriak, that He³ does not show a liquid-liquid transition to superfluidity in the temperature range of 0.3° to 2.3°K but that an anomalous specific heat exists that is associated with nuclear magnetic ordering, the maximum of the anomaly occurring between about 0.15° and 0.3°K. The theoretical interpretation of this behavior of pure liquid He³, which is so different from that of pure liquid He⁴, is very interesting and is not yet a completely solved problem. At this conference theoretical proposals toward its interpretation were put forward by many authors, including Rice, deBoer and Cohen, Buckingham, Price, Temperley, and Houston and Rorschach.

Current interest in the effects observable when nuclear spin systems are par-

Berkeley**NUCLEAR**

news notes

**data file
140****SETTING UP
A
RADIOISOTOPE
LABORATORY**

outlines AEC standards, describes program governing institutional use, individual practice training program, basic instrumentation; gives reference and source material. Write now for your free copy; please address Dep't. F-2.

Berkeley

division of Beckman Instruments Inc.
2200 Wright Ave., Richmond 3, Calif.



79

**Two Cambridge Monographs in
Experimental Biology****BIRD NAVIGATION**

By G. V. T. Matthews. Dr Matthews spent several years investigating the ability of birds to return home after long migrations or experimental displacement and carried out much of the critical research himself. He here orders and reviews the facts and experiments for the benefit of zoologists, physiologists, geo-physicists and practical navigators.

**THE PHYSIOLOGY OF
DIAPAUSE IN ARTHROPODS**

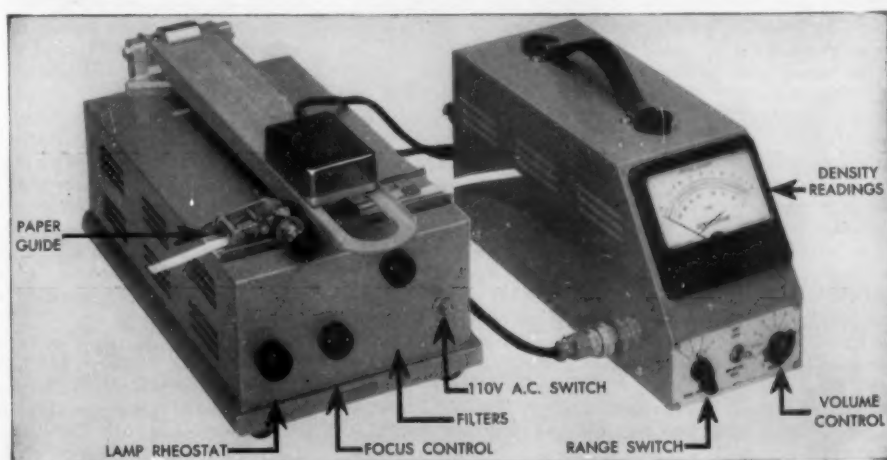
By A. D. Lees. Research on diapause shows that it is controlled by hormones and yet linked to definite external stimuli such as temperature and length of day. Knowledge of the metabolic and biochemical adjustments involved in the process has also been extended in recent years. The results of the research are reviewed and integrated by Dr Lees in this recent study.

\$2.50 each, through your bookseller

CAMBRIDGE UNIVERSITY PRESS
32 East 57th St., New York 22, N. Y.

**THE WELCH
DENSICHRON****TRANSMISSION DENSITOMETER
For PAPER CHROMATOGRAPHY**

Provides a Simple and Remarkable Technique for Quantitative Micro-Analysis



High
Sensitivity
and
Stability

Patent No.
2424933

No. 3835B

**Complete
\$425.00**

DENSICHRON WITH BLUE OR RED PROBE. This consists of the amplifier with logarithmic-scale meter, blue or red sensitive probe, metal probe support, five different measuring apertures, a cone with $\frac{1}{8}$ -inch aperture, and a set of instructions. The amplifier operates on 115 volts, 60-cycle A.C. only, except on special order.

TRANSMISSION LIGHT SOURCE UNIT. This is an enclosed light source powered by a constant-voltage transformer and equipped with a hinged arm for supporting the Densichron probe. The plate or film to be observed is placed over the aperture and the probe is lowered into position for a reading. Suitable controls are provided. It operates on 115 volts, 60 cycles, A.C.

W. M. WELCH SCIENTIFIC COMPANY
DIVISION OF W. M. WELCH MANUFACTURING COMPANY
— ESTABLISHED 1880 —

1515 Sedgwick Street, Dept. E, Chicago 10, Illinois, U. S. A.
Manufacturers of Scientific Instruments and Laboratory Apparatus

tially orientated in space was reflected by the presentation of six papers on this subject from five different institutions—Oxford University, University of Leiden, Ohio State University, Oak Ridge National Laboratory, and the National Bureau of Standards. One of these, on the polarization of In^{115} , by Roberts, Dabbs, and Bernstein was of especial significance in that it reported the direct magnetic polarization of the nuclei in indium metal by an external field. Thin plates of the metal were maintained in a magnetic field of 11,150 gauss at temperatures below 1°K , and a maximum nuclear polarization of about 2 percent was observed to occur at 0.043°K by noting the changes in the transmission of a beam of polarized neutrons.

In a business meeting the conference adopted a resolution recommending that delegates adopt a new temperature scale in the liquid helium temperature region. This new scale, designated T_{85} , is based on a thermodynamic formulation of the vapor pressure of pure liquid He^4 as a function of absolute temperature by van Dijk and Durieux, which was assessed to be correct to within 0.001°K at 1° and within 0.002° at the boiling point and to have the largest possible error of 0.003° at 2.8°K . It was agreed that this thermodynamic formula be used in conjunction with a correction curve proposed by Clement. This correction curve represents the most probable deviations from the formulation to be expected under certain defined methods of experimental measurement of the vapor pressure. Suitable tables embodying this T_{85} scale are being prepared for circulation by van Dijk and Durieux and by Clement, and these will represent a significant advance on the older, T_{80} , scale in its absolute precision. The conference, moreover, agreed that any formal adoption of an international scale of temperature in the helium temperature range be left to the advisory committee on thermometry of the Comité International des Poids et Mesures.

In connection with the measurement of very low temperature, an interesting report was given by Wolf on temperature measurements below 1°K made by Wolf, Cooke, and Meyer. The thermometric substance used was a spherical single crystal of cerium magnesium nitrate, which is known to follow closely Curie's law of paramagnetism to temperatures as low as 0.006°K . The paramagnetic substance for which the absolute temperature determination was required was in the form of a thin spherical layer of powder glued in good thermal contact around the thermometric sphere, and the ensemble was cooled below 1°K magnetically. Since cerium magnesium nitrate is strongly magnetically anisotropic, two simultaneous susceptibility measurements of the composite specimen made along and perpendicular to the axis of the

cerium magnesium nitrate single crystal were sufficient to determine the separate simultaneous susceptibilities of the single crystal and of the paramagnetic material under test. These results lead at once to a derivation of both the absolute (T) temperature and the magnetic (T^*) temperature of the test substance. T^* versus T determinations made in this way were reported for iron ammonium alum and neodymium magnesium nitrate.

J. G. DAUNT
*Department of Physics and Astronomy,
Ohio State University, Columbus*

Meeting Notes

■ The Vanderbilt University School of Medicine is sponsoring a symposium on the Pharmacology of the Autonomic Nervous System, 8-9 Feb. J. Harold Burn, professor of pharmacology at Oxford University, and this year's Abraham Flexner lecturer, will serve as moderator. The participants in the symposium are Earl Sutherland of Western Reserve University, Robert F. Furchgott of Washington University (St. Louis), Mark Nickerson of the University of Manitoba, David Nachmansohn of Columbia University, Irvine H. Page of the Cleveland Clinic Foundation, and David Grob of Johns Hopkins University.

■ New methods for the prevention of disease in farm animals were discussed at the 56th annual Conference of Veterinarians that was held at the University of Pennsylvania 3-4 Jan. under the auspices of the university's School of Veterinary Medicine. More than 300 veterinarians from a five-state area, representatives of Federal and state agencies, and veterinary leaders from abroad discussed the results of research that is directed toward improving animal health. Twenty-four sessions made up the program. At the annual banquet, Carleton S. Cpon, professor of anthropology and curator of general ethnology at the University Museum, was the principal speaker.

"New techniques in virology and their use in veterinary medicine" was the subject of a paper that was delivered by William F. McLimans, research associate professor of microbiology in veterinary medicine at the university. Copper deficiency in cattle was discussed by James A. Henderson of the Ontario Veterinary College, Guelph, Ontario, who described how cattle act when they are on a copper-deficient diet and how to prevent this deficiency.

New findings in air-sac disease among chickens were presented by Palace H. Seitz, poultry pathologist of the Pennsylvania State Bureau of Animal Industry, who led an afternoon session on respiratory diseases of poultry. Goose-

stepping pigs that may be so afflicted because of a vitamin deficiency were shown in a film; the causes of the affliction and preventive measures to be taken were discussed in a session that was led by Edward A. Schlif of the Agricultural Research Service, Trenton, N.J.

Other featured speakers were Aage T. Christensen of Copenhagen, Denmark, who considered canine hepatitis, and Floyd Cross, president of the American Veterinary Medical Association and dean of the Veterinary School, Colorado A. and M. College, who spoke on "Rhino-tracheitis of cattle." In addition, a panel of four participants discussed "Muzzle disease" of cattle. John Beck, professor of veterinary medicine at Pennsylvania, headed the faculty committee in charge of the conference.

■ Eleven specialists will present papers at the first international symposium on "Food physics: the application of physical principles in food research and production" to be sponsored jointly by Southwest Research Institute and the Institute of Food Technologists in San Antonio, Tex., 15-16 Mar. 1956. Purposes of the symposium are to show the benefits that have come to the food industry through the application of techniques drawn from the physical sciences and to discuss new developments that can be utilized to further advantage.

The contribution of physics to measurement and control will be brought out in reports on methods used in measuring physical properties of dough, crystallization in foods, and the measurement of quality in agricultural commodities. Nuclear magnetic resonance spectroscopy, a method for the rapid, nondestructive analysis of liquids and solids, and vapor chromatography, a technique for the separation and identification of volatile materials in foods, are two new methods that will be described.

How the automatic control of food processes by automation depends on measuring instruments based on physical principles will also be discussed. New methods of preserving and processing foods to be reviewed in the symposium include sterilization with atomic radiation, electrostatic smoking, radiofrequency heating, and processing with ultrasonics.

The technical papers will be followed by a round-table discussion in which all speakers will participate. For further information, write to the general chairman of the symposium, Mr. C. W. Smith, Southwest Research Institute, San Antonio, Tex.

■ The Society of American Military Engineers will hold its second Military Industrial Conference at the Palmer House, Chicago, Ill., 9-10 Feb. The theme of the conference is "National

RESEARCH BIOCHEMICALS

OF
HIGHEST POSSIBLE PURITY

A COMPLETE SELECTION

of

NUCLEOPROTEINS and
DERIVATIVES

All of Highest Possible Purity



FOR
INVESTIGATIONAL
USES

Typical Derivatives

ADENOSINE TRIPHOSPHATE
ADENINE
ADENOSINE DIPHOSPHATE
ADENYLIC ACID (Muscle) AMP
2-AMINO-4-METHYL PYRIMIDINE
COENZYME A
COZYMASE (Coenzyme 1)
CYTIDINE
CYTIDYLIC ACID
CYTOCHROME C
CYTOSINE
GLUCOSE-1-PHOSPHATE
TRIPHOSPHOPYRIDINE NUCLEOTIDE
URIDINE-5-PHOSPHATE
XANTHOSINE

WRITE FOR
NEW CATALOG

(November 1955)
OVER 1500 ITEMS

Write Dept. #102

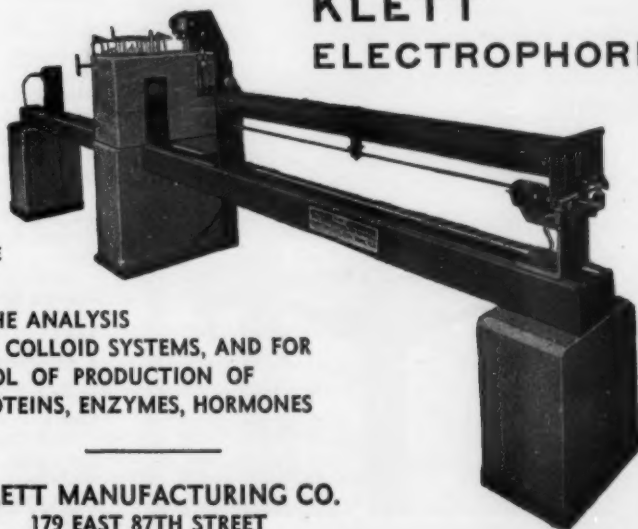


NUTRITIONAL BIOCHEMICALS
C O R P O R A T I O N

21010 MILES AVENUE

CLEVELAND 28, OHIO

KLETT ELECTROPHORESIS



CUSTOM MADE

TOOL FOR THE ANALYSIS
OF COMPLEX COLLOID SYSTEMS, AND FOR
THE CONTROL OF PRODUCTION OF
PURIFIED PROTEINS, ENZYMES, HORMONES

KLETT MANUFACTURING CO.
179 EAST 87TH STREET
NEW YORK, N. Y.

survival in the nuclear age." The sponsors and cooperating agencies of the meeting believe that an accurate and understandable presentation of nuclear defense is long overdue. The program of the conference is to be presented as a contribution to public understanding of the realities of nuclear warfare and the promise of technology in preventing or ameliorating its effects. For information, write to the Military Industrial Conference, 140 S. Dearborn St., Chicago 3.

■ The American Society for Artificial Internal Organs is soliciting papers for the 1956 meeting which will take place in Atlantic City, N.J., 15-16 Apr. in conjunction with the Federation meetings. Titles and outlines of proposed papers should be sent by 1 Mar. to Dr. P. F. Salisbury, 4751 Fountain Ave., Los Angeles 29, Calif.

Forthcoming Events

March

3-4. National Conf. and Workshop on Radio and Television Weather Presentation sponsored by American Meteorological Soc., Hartford, Conn. (K. C. Spengler, 3 Joy St., Boston 8, Mass.)

9-10. Midwest Conf. on Theoretical Physics, Iowa City, Iowa. (J. M. Jauch, Dept. of Physics, State Univ. of Iowa, Iowa City.)

12-16. National Assoc. of Corrosion Engineers, 12th annual, New York, N. Y. (Secretary, NACE, Southern Standard Bldg., Houston 2, Tex.)

14-17. National Science Teachers Assoc., Washington, D.C. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington 6.)

15-16. Food Physics Symposium, 1st international, San Antonio, Tex. (C. W. Smith, Southwest Research Inst., San Antonio.)

15-17. American Orthopsychiatric As-

soc., 33rd annual, New York, N.Y. (M. F. Langer, AOA, 1790 Broadway, New York 19.)

15-17. American Physical Soc., Pittsburgh, Pa. (K. K. Darrow, APS, Columbia Univ., New York 27.)

15-17. Kappa Delta Pi, annual, Stillwater, Okla. (E. I. F. Williams, 238 E. Perry St., Tiffin, Ohio.)

16-18. International Assoc. for Dental Research, St. Louis, Mo. (D. Y. Burrill, 129 E. Broadway, Louisville 2, Ky.)

17-18. National Soc. of Professional Engineers, annual spring, Washington, D.C. (K. E. Trombley, NSPE, 1121 13 St., NW, Washington 5.)

18-24. American Soc. of Photogrammetry, annual, joint meeting with American Cong. on Surveying and Mapping, Washington, D.C. (ACSM-ASP, Box 470, Washington 4.)

19-21. Div. of Fluid Dynamics, American Physical Soc., Pasadena, Calif. (F. N. Frenkiel, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.)

19-22. American Acad. of General Practice Scientific Assembly, 8th annual, Washington, D.C. (AAGP, Broadway at 34th, Kansas City 11, Mo.)

19-22. Inst. of Radio Engineers National Convention, New York. (E. K. Gammett, IRE, 1 E. 79 St., New York 21.)

19-23. American Soc. of Tool Engineers, Chicago, Ill. (H. C. Miller, Armour Research Foundation, 35 W. 33 St., Chicago 16.)

21-22. National Health Forum, New York, N.Y. (T. G. Klumpp, National Health Council, 1790 Broadway, New York 19.)

21-23. American Power Conf., 18th annual, Chicago, Ill. (R. A. Budenholzer, Illinois Institute of Technology, Chicago 16.)

21-24. American Astronomical Soc. Columbus, Ohio. (J. A. Hynek, McMillin Observatory, Ohio State Univ., Columbus.)

23-24. Eastern Psychological Assoc., Atlantic City, N.J. (G. G. Lane, Univ. of Delaware, Newark.)

23-24. North Carolina Acad. of Science, annual, Chapel Hill. (J. A. Yarbrough, Meredith College, Raleigh.)

24-25. American Psychosomatic Soc., 13th annual, Boston, Mass. (T. Lidz, APS, 551 Madison Ave., New York 22.)

24-31. Perspectives in Marine Biology, La Jolla, Calif. (A. A. Buzzati-Traverso, Scripps Institution of Oceanography, La Jolla.)

25-28. American Assoc. of Dental Schools, annual, St. Louis, Mo. (M. W. McCrea, 42 S. Greene St., Baltimore 1, Md.)

25-29. American College Personnel Assoc., Washington, D.C. (Miss C. M. Northrup, Univ. of Denver, Denver, Colo.)

28-3. Colloquium on Frontiers in Physical Optics, Boston, Mass. (S. S. Ballard, Visibility Laboratory, Scripps Institution of Oceanography, San Diego 52, Calif.)

29-31. Pennsylvania Acad. of Science, Indiana. (K. Dearolf, Public Museum and Art Gallery, Reading, Pa.)

29-31. Southern Soc. for Philosophy and Psychology, Asheville, N.C. (J. E. Moore, Georgia Inst. of Technology, Atlanta.)

(See issue of 20 January for comprehensive list)

the laboratory
"WORKHORSE"



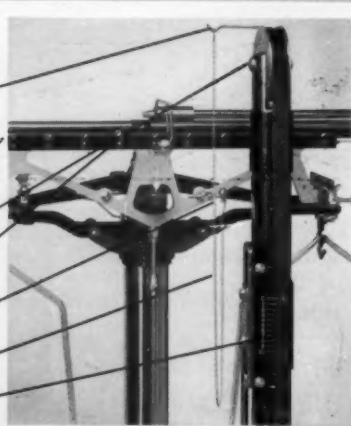
**AINSWORTH
CHAINWEIGHT
BALANCE**

• The chainweight type balance is the "workhorse" in many laboratories, large and small...it is a general purpose instrument, is fast, and inexpensive.

AINSWORTH Chainweight Balances are preferred by so many laboratories because they are rugged, reliable and accurate...give long, economical service.

ADVANTAGES OF AINSWORTH CHAINWEIGHT BALANCES

- Free hanging chain; no possibility of clippage, lost motion, or stretch between chain and indicator scale...more accurate
- Wide-spaced beam notches...spacing is less critical
- Ball bearing pulleys...easier, smoother operation
- Small beam weight...more reliable
- Patented jeweled chain mount...better reproducibility
- Solid 14K gold chain...not gold filled
- Adjustable eye-level vernier...easy to read, easy to set zero



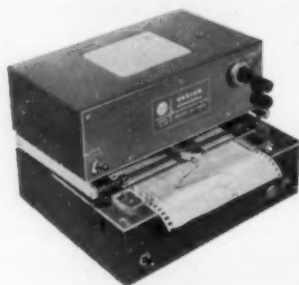
WM. AINSWORTH & SONS, INC.
2157 LAWRENCE STREET • DENVER 5, COLORADO

A COMPLETE LINE
of Analytical, Micro, Semi-Micro
and Assay Balances and Weights
...all with Ainsworth precision
and fine workmanship.

have you ever seen a graphic recorder with . . .

- ⊙ **PORTABILITY**...weighs less than 15 pounds, measures 10" x 7 1/2" x 8".
- ⊙ **VERSATILITY**...can be used as recording millivoltmeter or —with appropriate transducers — to record measurement of physical quantities.
- ⊙ **RECTILINEAR** trace representation.
- ⊙ **FULL CHART** zero positioning.
- ⊙ **HIGH INPUT** impedance and high allowable signal source impedance.
- ⊙ **PANEL** damping control for optimum stability.
- ⊙ **CHART DRIVE** extension for synchronization with other equipment.

**THE VARIAN G-10 GRAPHIC
RECORDER HAS ALL THESE
FEATURES AND MORE...IS
PRICED AT \$295**



WRITE TODAY FOR COMPLETE TECHNICAL DATA ON THIS REMARKABLE NEW INSTRUMENT AND ITS FULL ACCESSORY LINE.



Special Products Division
VARIAN associates
PALO ALTO 10, CALIFORNIA

Representatives in all principal cities
MICROWAVE TUBES — INSTRUMENTS

Equipment News

■ **MICROMANIPULATOR** will duplicate on a microscopic scale any possible movement that a hand will communicate to a single control lever. The design permits the control lever to be placed in such a way that the hand of the user rests in a relaxed position. The Cailloux micromanipulator, which is designed for use with magnifications of 100 to 2000, corrects for reverse movements and is free of parasitic vibrations. The instrument is furnished with six microtools. (C. H. Stoelting Co., Dept. Sci., 424 North Homan Ave., Chicago 24, Ill.)

■ **SPECTRAL LAMP** employs 12 bulbs for work throughout the spectrum. The 12 bulbs, cadmium, cesium, helium, mercury; mercury-cadmium, potassium, sodium, neon, rubidium, thallium, zinc, and a second mercury bulb with a window-like opening in the outer bulb for short-wave ultraviolet are used interchangeably in one auxiliary operating unit. The lamps are equipped with pre-focus bases and identical light center lengths. (George W. Gates and Co., Inc., Dept. Sci., Hempstead Turnpike and Lucile Ave., Franklin Square, N.Y.)

■ **CONTINUOUS-FLOW PAPER ELECTROPHORESIS APPARATUS** has a new method of electrolyte feed and wide-range controls that permit the instrument to give maximum throughput under any required degree of resolution. Resolutions that formerly required as much as 1500-v operation can be made at 1/3 this value. The instrument is applicable to the separation of charged substances such as proteins, polypeptides, amino acids, and other biological materials, as well as such organic substances as dyes and intermediates. In special cases, nonpolar substances such as carbohydrates can be separated. Large-volume vertical wicks between the curtain and electrode vessels provide optimal distribution of the electric field and prevent migration of electrode products into the paper curtain. Controls permit adjustment of feed point and positioning and orientation of the pattern. (Spinco Division, Beckman Instruments, Inc., Dept. Sci., 732 O'Neill Ave., Belmont, Calif.)

■ **PHOTOELECTRIC ANALYZER** model III, an instrument for automatically analyzing, recording, and controlling chemical processes involving liquids, vapors, or gases, has been announced. Automatic recording without auxiliary attendance is possible because the instrument periodically and automatically checks and resets itself to compensate for any smudge accumulation on cell windows or other similar sources of error. (Manufacturers Engineering and Equipment Corporation, Dept. Sci., Hatboro, Pa.)

OPTICAL BARGAINS

See the Stars, Moon, Planets Close Up!
**BUILD A BIG 100 POWER, 3" REFLECTING
TELESCOPE**



With This Complete \$7 Price "Do-It-Yourself" KIT Everything you need! No machining! Easily assembled! We furnish complete, simple instructions. Kit includes: 3" f/10 aluminized and evacuated Spherical Mirror—80X Eyepiece and 100X Barlow Lens—Cross-line Finder—sturdy 40" Tripod—fork type Equatorial Mount with locks on both axes—ventilated 3" Mirror Mount—heavy wall, Black Telescope Tube. All nuts and bolts supplied. Nothing extra to buy. Our 3" Spherical Mirror (80" f.l.) is guaranteed to receive detail right up to theoretical limit. Your finished scope can also be used terrestrially. Money back guarantee. Shpg. wt., 10 lbs. Stock No. 85,025-W .. \$29.50 f.a.b. Barrington, N. J.

**50-150-300 Power
MICROSCOPE**
Low Price Yet Suitable for Classroom
Use! Only \$14.95
3 Achromatic Objective Lenses on
Revolving Turret!

Important! The color-corrected, cemented achromatic lenses in the objectives give you far superior results to the single lenses found in the microscopes selling for \$9.95! Results are worth the difference! Fine rack and pinion focusing. Stock No. 70,008-W \$14.95 Postpaid



**OPTICAL
COLLIMATOR**
War Surplus

Designed to check navigational instruments. Used by industry as a collimator for optical instruments, for testing lenses for defocusing issues for defocusing reticles at infinity. Purchased by many firms as a source for the fine lenses and parts it contains. Consists of a large cemented achromat, 5" in diameter, with a focal length of approximately 25", a pinpoint reticle lighted by a 6-8-volt bulb (to represent a star), a first-surface mirror to reflect the light from the reticle. Overall length 14 1/2"; width of cradle 7 1/2". Slightly used, but in good working order. Stock No. 80,025-W .. \$95.00 f.a.b. Barrington, N. J.

POCKET COMPARATOR

Check, Measure, Inspect Small Parts and Dimensions with 6 POWER MAGNIFICATION

MEASURES
• Angles
• Radii • Circles
• Linear—in both decimal inches and millimeters.



**HANDY!
FAST! ACCURATE!**

Fine, imported measuring magnifier—for fast, accurate inspections. Black anodized metal cell. Clear Plastic lens. Focusing adjustment. Comes in protective leather case. Money-back guarantee! Stock No. 90,061-W .. New Low Price .. \$19.50 Postpaid

**New! 2 in 1 Combination!
Pocket-Size
50 Power MICROSCOPE
and
10 Power TELESCOPE**

ONLY
\$4.50
ppd.



Useful Telescope and Microscope combined in one amazing, precision instrument. Imported! No larger than a fountain pen. Telescope is 10 Power. Microscope magnifies 50 Times. Sharp focus at any range. Handy for sports, looking at small objects, just plain snooping.

Send Check or M.O.
Satisfaction Guaranteed

Order Stock No. 30,059-W .. \$4.50

WRITE FOR FREE CATALOG-W

Huge selection of lenses, prisms, war surplus optical instruments, parts and accessories. Telescopes, microscopes, binoculars. Hand spectrometers, reticles, mirrors, Bonch's rulings, dozens of other hard-to-get optical items. America's No. 1 source of supply for Photographers, Hobbyists, Telescope Makers, etc. Ask for catalog W

Order by Stock No. Send Check or M.O.
Satisfaction Guaranteed!

EDMUND SCIENTIFIC CORP.
BARRINGTON, NEW JERSEY

PERSONNEL PLACEMENT

CLASSIFIED: 18¢ per word, minimum charge \$3.60. Use of Box Number counts as 10 additional words.

COPY for classified ads must reach SCIENCE 2 weeks before date of issue (Friday of every week).

DISPLAY: Rates listed below — no charge for Box Number. Monthly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

Single insertion	\$22.00 per inch
13 times in 1 year	21.00 per inch
26 times in 1 year	20.00 per inch
52 times in 1 year	19.00 per inch

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

POSITIONS WANTED

Bacteriologist, Ph.D. Since 1948 senior bacteriologist and administrative assistant to research director; has been associated with the organic chemistry and pharmacology divisions in the research and development of new therapeutics and pharmaceuticals. Medical Bureau (Burnice Larson, Director), Palmolive Building, Chicago. X

Invertebrate Zoologist (Marine), Ph.D. Experienced teacher desires change—teaching, research, or museum. Box 23, SCIENCE. X

Neurophysiologist, Ph.D. Electrophysiology, stereotaxic, and so forth. Publications. Three years' teaching, Assistant Professor, mammalian, general, neurophysiology. A.B., M.A., Anatomy. Desires teaching with adequate time for research. Box 20, SCIENCE. 2/10

Pharmacologist; early 50's; Ph.D. chemistry, physical chemistry; nearly 20 years' experience, administration and direction of pharmaceutical research with well-known organizations; highly recommended; \$15,000; prefers East but will consider any location. Woodward Medical Bureau, 185 North Wabash, Chicago. X

Virologist, Ph.D. Experienced in publications. Desires research position in university or industry. Box 22, SCIENCE. X

Zoologist; doctorate, 36, research and teaching experience; desires teaching position with responsibility. Box 21, SCIENCE. X

POSITIONS OPEN

Biochemist, M.S. or B.S., preferably with experience to assist in research. Permanent position, starting salary to \$5400 with yearly increases. Send complete résumé and photograph to Dr. David S. Kinnory, Dept. of Biochemistry, Loyola University, 706 South Wolcott, Chicago 12, Illinois. 2/10

Histology—Research Technician: Immediate appointment. Some previous experience required. Tissue preparation and participation in activities of group engaged in medical research. Permanent positions; 40-hour week; extra benefits. May Institute for Medical Research. Write to Personnel Manager, Jewish Hospital Association, Cincinnati 29, Ohio. X

MATHEMATICIANS ON CAPE COD

This private scientific research laboratory has an immediate opening for a computer in the meteorological section. Requirements: a bachelor's degree in mathematics desirable but not essential. Would accept person who has good academic record in differential equations. In replying, please write giving complete statement regarding education, training, and experience. If called for interview, we will pay travel expenses. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. 1/27; 2/3, 10

Pharmacologist. Vacancy in our laboratories for Research Associate, M.S. degree, with some experience in neurophysiology and electroencephalography. In confidence, send complete résumé and salary requirements. Schering Corp., Manufacturer of Fine Pharmaceuticals, 60 Orange St., Bloomfield, N. J. X

PHYSICIANS WANTED

Associate or assistant pathologist to Dr. David R. Meranze, Board certified or eligible. Major, general hospital, medical school affiliated; active teaching and research institution. Highly qualified staff. Albert Einstein Medical Center, Southern Division, Philadelphia 47, Pa. 2/3, 10, 27

Physiologist: teaching and research. Training or interest in gastroenterology, neurophysiology, electronics desirable. Excellent facilities. Salary and rank dependent on qualifications. Dr. J. P. Quigley, Department of Physiology, University of Tennessee, Memphis. 2/3

POSITIONS OPEN

POSITIONS REQUIRING DEGREES IN MEDICINE OR SCIENCE: (a) Manufacturing Biochemist; Ph.D. with manufacturing experience; supervise manufacture of biological products; to \$8500; important Eastern pharmaceutical house. (b) Pharmacology Instructor; prefer experienced electronic equipment as used in cardiovascular research; well-known Eastern medical school. (c) Experimental Immunologist; M.D. or Ph.D.; research laboratories, 250-bed tuberculosis hospital; medical school affiliations; West. (d) Bacteriologist; M.A. and hospital or medical school experience; head department, very large general hospital; well-equipped and active laboratory; teaching opportunity, nursing and technology schools; desirable university city; Mideast. (e) Biochemist; approved 250-bed general hospital; college city of 100,000; Southwest. (f) Research Serologist or Immunochemist; Ph.D. preferred, with streptococcal experience; research, principally rheumatic fever, allied diseases; important Eastern medical school. For further information write Woodward Medical Bureau, 185 North Wabash, Chicago. X

(a) Technical Service Specialist; Ph.D., Pharmacy or Pharmaceutical Chemistry; minimum 10 years' general pharmaceutical experience (5 years in manufacture of pharmaceutical products preferred); \$9000-13,000; East. (b) Director or Associate Director, Clinical Research; pharmaceutical company; East; \$20,000; physician required. (c) Chemist, Analytical or Physical; well-known laboratory engaged in practical research; opportunity for medical-school faculty appointment; \$10,000-12,000; Midwest. (d) Biochemist, Ph.D., and Bacteriologist, minimum M.S., head 450-bed teaching hospital; expanding facilities; university center, East; minimum \$7000 and \$5500, respectively. S2-1 Medical Bureau (Burnice Larson, Director), Palmolive Building, Chicago. X

GRANTS

Graduate Assistantships in Teaching and Research available for September, 1956. Load 12 or 6 hours per week. Remainder of time available for graduate work leading to Master's degree. Stipends range from \$550 to \$2000.

Teaching Fellowships for Advanced Graduate Students. Load 15 hours. Stipend, \$1800.

Contact Chemistry Department, Howard University, Washington 1, D.C. 3/30

BOOKS AND MAGAZINES

WANTED TO PURCHASE...

SCIENTIFIC PERIODICALS and BOOKS

Sets and runs, foreign and domestic. Entire libraries and smaller collections wanted.

WALTER J. JOHNSON, INC.
125 E. 23rd St., New York 10, N. Y.

Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A35, J. S. CANNER, Inc. Boston 19, Massachusetts

BOOKS AND MAGAZINES

SCIENTIFIC JOURNALS WANTED

Sets, Runs and Volumes bought at top prices. Your wants supplied from our Back Files of over 3,000,000 periodicals. Abrahams Magazine Service; N. Y. 3, N. Y.

Scientific Periodicals Bought at Top Prices

ASHLEY-RATCLIFF CORP.
27 East 21st Street New York 10, N. Y.

PROFESSIONAL SERVICES

BOOK MANUSCRIPTS INVITED

Write for Free Booklet SC telling how we can publish your book. All subjects considered. New authors welcome. VANTAGE PRESS, Inc. • 120 W. 31 St., N. Y. 1 In Calif.: 6253 Hollywood Blvd., Hollywood 28



The Market Place

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

DISPLAY: Rates listed below — no charge for Box Number. Monthly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

Single insertion	\$22.00 per inch
13 times in 1 year	21.00 per inch
26 times in 1 year	20.00 per inch
52 times in 1 year	19.00 per inch

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT



PROFESSIONAL SERVICES

WISCONSIN ALUMNI RESEARCH FOUNDATION

LABORATORY SERVICES

Project research and consultation in Bio-chemistry, Chemistry, Bacteriology and Entomology

Screening of compounds for insecticidal, fungicidal and bactericidal properties • Biological evaluation and chemical determination of insecticides • Peet-Grady and C.S.M.A. aerosol tests • Warfarin assays

Write for price schedule

WISCONSIN ALUMNI RESEARCH FOUNDATION
P. O. BOX 2217 V MADISON 1, WIS.

LaWall & Harrison SINCE 1870

Div. 5, 1521 Walnut St., Philadelphia 2, Pa.

Food & Drug PROBLEMS

Pharmacological BACTERIOLOGICAL CHEMICAL

SUPPLIES AND EQUIPMENT

EXO - KETON PLASTIC COVERSLIPS

- UNBREAKABLE
- WON'T CUT FINGERS
- FLEXIBLE, yet
- WILL NOT CURL!
- 1/4 THE PRICE OF GLASS

Also available through your local dealer

CHARLES F. HUBBS AND CO.
Established 1853
53-01 115th St. L.I.C. 1, N.Y.
Division Hubbs Corp.

SUPPLIES AND EQUIPMENT

THE JUNIOR Garceau
Electroencephalograph
Price \$575.00 complete.

No Batteries
Requires no Shielding
Prompt Delivery
A.C. Operated
Inkless Writing
Shipped Ready to Run

ELECTRO-MEDICAL LABORATORY, INC.
South Woodstock 2, Vermont

CONSISTENT RATS & MICE

BUDD MT. RODENT FARM
CHESTER, N. J.

Breeders of a recognized strain
of Wistar rats and W.S. mice

Microscopists:

- Send your name and address for information on
- Cargille Non-Drying Immersion Oil
 - Allen Reference Sets (for microscopy) of
 - a) Minerals
 - b) Animal Hairs
 - c) Fur Hairs
 - d) Starches & Food Condiments
 - High Index Mounting Medium
 - Index of Refraction Liquids (1.35-2.11)
 - Book: "Practical Refractometry By Means of the Microscope"
 - New pencil for marking glass, plastics, mineral specimens with hairline marks, permanent if desired.

R. P. Cargille Laboratories, Inc.
117 Liberty St. New York 6, N.Y.

SUPPLIES AND EQUIPMENT

albino rats* "From the hand of the veterinarian to research"

Hypophysectomized Rats
*Descendants of the Sprague-Dawley and Wistar Strains

HENRY L. FOSTER, D.V.M.
President and Director
THE CHARLES RIVER BREEDING LABS.
Dept. B, Wilmington, Mass.

PALO LABORATORY STIRRER Model #7605

\$22.55

One of complete line of laboratory-tested PALO Stirrers. Inexpensive, thoroughly reliable, suitable for most laboratory stirring operations.

Write for Bulletin X-1.

PALO LABORATORY SUPPLIES, Inc.
81 Knolls St., New York 7

ALBINO RATS

Our mass production methods insure greatest uniformity and consistency

Price list on request

DAN ROLFSMEYER CO. ■ Ph. 6-6149
Route 3, Syene Road, Madison, Wisconsin

STAINS—GURR'S—INDICATORS
FREE PRICE LIST
ESBE LABORATORY SUPPLIES
459 Bloor St., W. Toronto, Canada

SPRAGUE - DAWLEY, INC.

PIONEERS IN THE DEVELOPMENT OF THE STANDARD LABORATORY RAT.

All shipments made from our new modern, quarantined colony.

SPRAGUE-DAWLEY, INC. - P. O. BOX 2071

Phone CEder 3-5318

Madison, Wisconsin

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT



SUPPLIES AND EQUIPMENT

SUPPLIES AND EQUIPMENT

SUPPLIES AND EQUIPMENT

LOOK

in our September,

1955 - CATALOGUE

if you need amino acids, biological stains, high-vacuum desiccated animal glands, indicators, microbiological assay media and (aluminum) racks, peptides, purines, pyrimidines, vitamins and other

RESEARCH - CHEMICALS

Write for catalogue

H. M. CHEMICAL COMPANY, LTD.

1651 - 18th Street

Santa Monica, California

HOLTZMAN RAT CO.

... uniformity in response from group to group and year to year.

Rt. 4, Box 205 Madison 4, Wisc.
Phone Alpine 6-5573



FORMICA LINED CHROMATOGRAPHIC CABINETS

FOR 12 PAPERS \$87.50

THE CHROMATOGRAPHY CO.
463 Fairfield Pl. Yellow Springs, Ohio



SEND FOR DETAILS
ON THE NEW,
ULTRA-COMPACT
GME-LARDY WARBURG
APPARATUS

LEISS

Single and Double MIRROR-MONOCHROMATORS



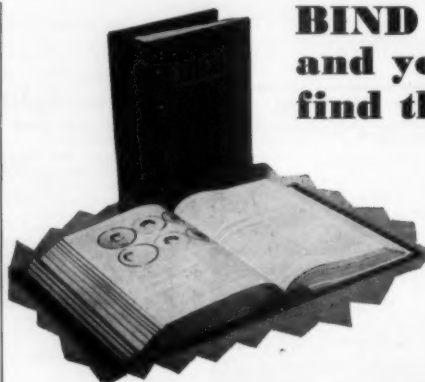
with exchangeable prisms for the visible, ultraviolet, infrared from 200 millimicrons to 20 microns

Write for Bulletin #980 to

PHOTOVOLT CORP.

95 Madison Ave.

New York 16, N. Y.



BIND 'EM...
and you'll
find them!

Keep your copies of **SCIENCE** always available for quick, easy reference in this attractive, practical binder. Simply snap the magazine in or out in a few seconds—no punching or mutilating. It opens **FLAT**—for easy reference and readability. Sturdily constructed—holds 26 issues.

This beautiful maroon buckram binder stamped in gold leaf will make a fine addition to your library. Only \$3.25 postpaid; add 50¢ for orders outside U.S.A. (Personal check or money order, please.) Name of owner, 75¢ extra; year of issue, 50¢ extra.

SCIENCE

• 1515 Massachusetts Ave., NW,
Washington 5, D.C.

Leitz**first in precision optics**

LEITZ NEW FREEZING MICROTOME

Considerably larger than our standard freezing microtome, this sturdily built instrument has built-in specimen and cooling arrangements, thus eliminating all but one carbon dioxide cable. Sections may be cut at variable thicknesses from 2.5 to 50 microns. Adjustable object clamps are available, as well as paraffin and freezing stages of 50 and 35 mm. diameters. Guaranteed to give you better frozen sections more rapidly.



11399

A reputation for integrity and a tradition of service have led thousands of scientific workers to bring their optical problems to Leitz. If you have problems in this field, why not let us help you with them?

See your Leitz dealer and examine these Leitz instruments soon. Write for information.

E. LEITZ, INC., Dept. SC-2
468 Fourth Avenue, New York 16, N. Y.

Please send me the Leitz _____ brochure.

NAME _____

STREET _____

CITY _____ ZONE _____ STATE _____

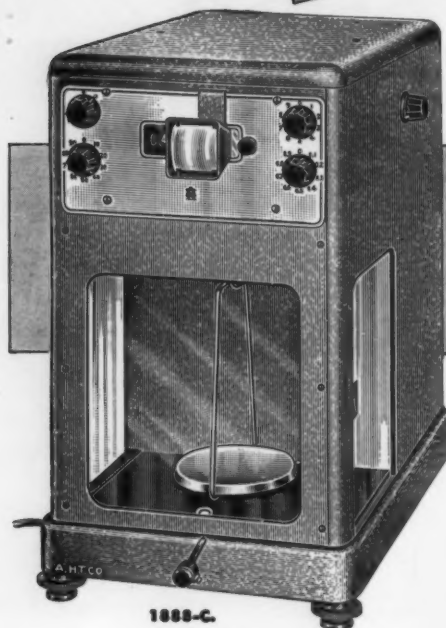
E. LEITZ, INC., 468 FOURTH AVENUE, NEW YORK 16, N. Y.
Distributors of the world-famous products of Ernst Leitz, Wetzlar, Germany
LENSES • CAMERAS • MICROSCOPES • BINOCULARS

METTLER

**RAPID
WEIGHING
DIRECT READING**

BALANCES

**including
SEMIMICRO
and MICRO**



1888-C.

ANALYTICAL BALANCES, Mettler. Single pan, direct reading, rapid weighing, accurate Balances with built-in Stainless steel weights operated by dials on front panel. Made in Switzerland and in satisfactory use throughout the world for the past nine years; now assembled—with the exception of the Micro model—and serviced in maker's U.S.A. branch.

Operate on the principle of weighing by substitution on a single pan with beam subject

◀ **RAPID, ACCURATE WEIGHING**
by dialing built-in weights
in less than 30 seconds

◀ **CONSTANT SENSITIVITY**

to constant load throughout the entire range, which method is recognized as highly accurate. Operation is simple and weighings can be completed in less than 30 seconds. Total weight is read directly from indicator on front panel. Sensitivity is constant throughout the weighing range.

The specially engineered packing includes all tools necessary for installation.

1867-J. Balance, Analytical, Mettler B-5, capacity 200 grams, accuracy ± 0.1 mg. With air damper and transformer for 110, 125, 145 or 220 volts, 50 or 60 cycles a.c., but without magnifier-light shield **\$95.00**

1888-C. Balance, Semimicro, Mettler B-6, similar to 1867-J but with capacity 100 grams, accuracy within optical range ± 0.02 mg, accuracy of entire set of weights ± 0.1 mg, and with magnifier-light shield **\$95.00**

1888-M. Balance, Microchemical, Mettler M-5, with recently improved damping device, capacity 20 grams, accuracy within optical range ± 0.002 mg, accuracy of entire set of weights ± 0.02 mg. With front radiation shield and magnifier-light shield **1,380.00**

Copy of Bulletin 127 sent upon request.

QUALITY AND SERVICE
A. H. T. CO.
PHILA. U.S.A.
LABORATORY APPARATUS
More and More
Laboratories
RELY ON THOMAS

ARTHUR H. THOMAS COMPANY

Laboratory Apparatus and Reagents

P. O. BOX 779

PHILADELPHIA 5, PA.

